STORM KING ART CENTER

PHASE 1

Construction Specifications

for the

CONSERVATION, FABRICATION, AND MAINTENANCE (C.F.M.) BUILDING

90% Construction Documents
April 16th, 2021

TABLE OF CONTENTS

CONSERVATION, FABRICATION, AND MAINTENANCE (C.F.M.) BUILDING

DIVISION 1 GENERAL REQUIREMENTS

SECTION

011100	Summary of Work
013113	Project Coordination
013119	Project Meetings
013300	Submittal Procedures
014000	Quality Requirements
014339	Mock-Ups
014523	Testing and Inspection
015000	Temporary Facilities and Controls
015639	Temporary Tree and Plant Protection
016000	Product Requirements
017300	Execution Requirements
017700	Closeout Procedures
017823	Operation and Maintenance Data
018900	Site Construction Performance Requirements

DIVISION 2 EXISTING CONDITIONS

SECTION

024113	Selective Site Demolition and Removals

DIVISION 3 CONCRETE

SECTION

033000	Cast-in-Place Concrete
033055	Cast-in-Place Concrete (Site)
033315	Architectural Topping Slabs
033543	Polished Concrete Finishing

DIVISION 4 MASONRY

NOT USED

DIVISION 5 METALS

SECTION

051200	Structural Steel
052100	Steel Joist Framing
053100	Steel Decking
054100	Cold-Formed Metal Framing
055000	Miscellaneous Metals
055113	Steel Pan Stairs
057000	Ornamental Metals

DIVISION 6 WOOD, PLASTICS AND COMPOSITES

SECTION

062000	Carpentry
064023	Architectural Woodwork

DIVISION 7 THERMAL AND MOISTURE PROTECTION

SECTION

071326	Sheet Membrane Waterproofing
072100	Exterior Thermal Insulation (Above Grade)
072120	Thermal Insulation (Below Grade)
072616	Below-Grade Vapor Retarder
072700	Exterior Self-Adhering Sheet Air Barriers
074213	Exterior Insulated Metal Panel System
075400	Thermoplastic (TPO) Membrane Roofing
076200	Sheet Metal Flashing
077100	Roof Specialties and Accessories
078413	Firestops and Smokeseals
079200	Joint Sealers
079500	Expansion Control

DIVISION 8 OPENINGS

SECTION

081113	Steel Doors and Frames
083000	Interior Glazed Partition Systems
083113	Access Panels
083323	Overhead Coiling Doors
083919	Watertight Access Hatch
085100	Exterior Metal-Framed Windows and Doors
086200	Unit Skylights
087100	Door Hardware (C.F.M. Building)
088000	Exterior Glass and Glazing
088100	Interior Glass and Glazing
089000	Louvers

DIVISION 9 FINISHES

SECTION

092900	Gypsum Drywall
093013	Ceramic Tiling
095113	Acoustical Panel Ceilings
096513	Resilient Base and Accessories
096543	Linoleum Flooring
097200	Wallcovering
097800	Reinforced Plastic Paneling System
099000	Painting and Finishing

DIVISION 10 SPECIALTIES

SECTION

101100	Visual Display Surfaces
101400	Signage
101455	Traffic and Regulatory Signage (Site)
102813	Toilet Accessories
104416	Fire Extinguishers and Cabinets
105113	Wood Lockers

DIVISION 11 EQUIPMENT

SECTION

113100	Appliances

DIVISION 12 FURNISHINGS

SECTION

122413	Window Shades

DIVISION 13 SPECIAL CONSTRUCTION

NOT USED

DIVISION 14 CONVEYING EQUIPMENT

SECTION

142600	Limited Use/ Limited Application (LU/LA) Elevator

DIVISION 21 FIRE SUPPRESSION

SECTION

210000	Fire Protection General Requirements
210513	Common Motor Requirements For Fire Suppression Equipment
210517	Sleeves And Sleeve Seals For Fire-Suppression Piping
210518	Escutcheons For Fire-Suppression Piping
210523	General-Duty Valves For Water-Based Fire-Suppression Piping
210533	Heat Tracing For Fire-Suppression Piping
210553	Identification For Fire-Suppression Piping And Equipment
211313	Wet-Pipe Sprinkler Systems
213116	Diesel-Drive, Centrifugal Fire Pumps

DIVISION 22 PLUMBING

SECTION

220000	Plumbing General Requirements

220517 Sleeves And Sleeve Seals For Plumbing Piping
220518 Escutcheons For Plumbing Piping
220519 Meters And Gages For Plumbing Piping
220523.12 Ball Valves For Plumbing Piping
220523.13 Butterfly Valves For Plumbing Piping
220523.14 Check Valves For Plumbing Piping
220523.15 Gate Valves For Plumbing Piping
220529 Hangers And Supports For Plumbing Piping And Equipment
220533 Heat Tracing for Plumbing Piping
220553 Identification For Plumbing Piping And Equipment
220719 Plumbing Piping Insulation
221116 Domestic Water Piping
221119 Domestic Water Piping Specialties
221123 Domestic Water Pumps
221316 Sanitary Waste And Vent Piping
221319 Sanitary Waste Piping Specialties
221319.13 Sanitary Drains
221423 Storm Drainage Piping Specialties
223300 Electric, Domestic-Water Heaters
224213 Commercial Water Closets
224216 Commercial Lavatories

DIVISION 23 HEATING, VENTILATING AND AIR CONDITIONING

SECTION

230000 Mechanical General Requirements
230513 Common Motor Requirements For HVAC Equipment
230516 Expansion Fittings And Loops For HVAC Piping
230517 Sleeves And Sleeve Seals For HVAC Piping
230518 Escutcheons For HVAC Piping
230519 Meters And Gages For HVAC Piping
230529 Hangers And Supports For HVAC Piping And Equipment
230548.13 Vibration Controls For HVAC
230553 Identification For HVAC Piping And Equipment
230593 Testing, Adjusting, And Balancing For HVAC
230713 Duct Insulation
230719 HVAC Piping Insulation
230800 Commissioning Of HVAC
230900 Instrumentation And Controls For HVAC
230993 Sequence Of Operations For HVAC DDC
232300 Refrigerant Piping
233113 Metal Ducts
233300 Air Duct Accessories
233423 HVAC Power Ventilators
233600 Air Terminal Units
233713.13 Air Diffusers
237219 Fixed Plate Air-To-Air Energy Recovery Units
237313 Custom Air-Handling Units
238129 Variable Refrigerant Flow HVAC Systems
238216 Electric-Resistance Air Coils
238239 Cabinet Unit Heaters

BH: NO LONGER APPLICABLE TO CFM PROJECT.

DIVISION 26 ELECTRICAL

SECTION

260000	Electrical General Requirements
260519	Low-Voltage Electrical Power Conductors And Cables
260523	Control-Voltage Electrical Power Cables
260526	Grounding And Bonding For Electrical Systems
260529	Hangers And Supports For Electrical Systems
260533	Raceways And Boxes For Electrical Systems
260543	Underground Ducts And Raceways For Electrical Systems
260544	Sleeves And Sleeve Seals For Electrical Raceways And Cabling
260553	Identification For Electrical Systems
260573.16	Overcurrent Protective Device Studies
260923	Lighting Control Devices
262200	Low-Voltage Transformers
262413	Switchboards
262416	Panelboards
262713	Electricity Metering
262726	Wiring Devices
262813	Fuses
262816	Enclosed Switches And Circuit Breakers
262913	Enclosed Controllers
263213.13	Diesel Emergency Engine Generators
263323.11	Central Battery Equipment For Emergency Lighting
263600	Transfer Switches
264113	Lightning Protection For Structures
265000	Luminaries
265219	Emergency And Exit Lighting

BH: NO LONGER APPLICABLE TO CFM PROJECT

DIVISION 27 COMMUNICATIONS

SECTION

270000	Communications Systems
270526	Grounding And Bonding For Communications
270536	Cable Trays For Communications Systems
271100	Communications Equipment Room Fittings
271323	Communications Optical Fiber Backbone Cabling
271513	Communications Copper Horizontal Cabling
272000	Data Communications Systems
274116	Integrated Audiovisual Systems and Equipment

DIVISION 28 ELECTRONIC SAFETY AND SECURITY

SECTION

280000	Security Systems
283111	Digital Addressable Fire Alarm System

DIVISION 31 EARTHWORK

SECTION

310000	Earthwork

311000 Site Clearing
311100 Clearing and Grubbing
311300 Selective Tree and Shrub Removal and Trimming
312300 Site Excavating, Backfilling and Compacting
312500 Erosion and Sediment Controls

DIVISION 32 EXTERIOR IMPROVEMENTS

SECTION

321100 Base Courses (Pavement)
321216 Bituminous Paving
321313 Portland Cement Concrete Pavement
321314 Exposed Aggregate Concrete Pavement
321543 Stabilized Stone Dust Paving
321640 Granite Curb
321723 Pavement Markings
323113 Chain Link Fencing and Gates
323129 Wood, Wire and Mesh Fencing and Gates
323900 Bollards
329115 Planting Soil
329119 Landscape Grading
329200 Lawns and Grasses
329300 Planting
329448 Stainless Steel Plant Support
329643 Tree Protection and Transplanting

DIVISION 33 UTILITIES

SECTION

331000 Water Utilities
333900 Sanitary Utility Sewerage Structures
334000 Storm Drainage Utilities
334020 Warning and Tracer Tape
334723 Subsurface Wastewater Disposal System

DIVISION 41 MATERIAL PROCESSING AND HANDLING EQUIPMENT

SECTION

413423 Semi-Downdraft Spray Paint Booth

SECTION 011100

SUMMARY OF WORK

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Permits and Fees: Apply for, obtain, and pay for trade permits, fees, and utility company back charges required to perform the work. Submit copies to Architect.

B. Codes: Comply with applicable codes and regulations of authorities having jurisdiction. Submit copies of inspection reports, notices and similar communications to Architect.

C. Dimensions: Verify dimensions indicated on drawings with field dimensions before fabrication or ordering of materials. Do not scale drawings.

D. Existing Conditions: Notify Architect of existing site conditions differing from those indicated on the drawings. Do not remove or alter structural components without prior written approval.

E. Coordination

1. Coordinate the work of all trades.

2. Prepare coordination drawings for areas above ceilings where close tolerances are required between building elements and mechanical and electrical work.

3. Verify location of utilities and existing conditions.

F. Installation Requirements, General

1. Inspect substrates and report unsatisfactory conditions in writing.

2. Do not proceed until unsatisfactory conditions have been corrected.

3. Take field measurements prior to fabrication where practical. Form to required shapes and sizes with true edges, lines, and angles. Provide inserts and templates as needed for work of other trades.

4. Install materials in accordance with manufacturer’s instructions and approved submittals.

5. Install materials in proper relation with adjacent construction and with proper appearance.

6. Restore units damaged during installation. Replace units which cannot be restored, with no additional expense to the Owner.

7. Refer to additional installation requirements and tolerances specified under individual specification sections.

G. Repair damage caused by construction operations.

PART 2 PRODUCTS

(Not Applicable)

PART 3 EXECUTION

(Not Applicable)

END OF SECTION

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.

B. 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.

1.5 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 Change Order Requests.

12. 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 per Project Managament Software: 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 seven 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 Owner/Contractor Agreement.

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.

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.

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 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. 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.

12. 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.

13. 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.

14. 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.

15. 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.

16. 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.

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.

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 2 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.

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

1.1 GENERAL MOCK-UP REQUIREMENTS

A. Unless otherwise indicated, approved mock-ups establish the standard by which the Work will be judged.

1. Approval of mock-ups does not constitute approval of deviations from the Contract Documents contained in mock-ups unless Architect specifically approves such deviations in writing.

B. Schedule/Program mock-up at the outset to allow sufficient time for review and approval prior to commencement of main works procurement

C. Build mock-ups in location and of the size indicated or, if not indicated, as directed by the Architect. Provide BIM integrated model as shop drawings of intended mock-up as well as all submittals, samples, and datasheets for approval prior to installation.

1. Where applicable, mock-ups shall be viewable from the interior side as well as the exterior, under natural daylight conditions.

D. Notify the Architect seven days in advance of dates and times when mock-ups will be constructed.

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

F. Obtain Architect’s approval of mock-ups before starting installation.

G. Maintain mock-ups during construction in an undisturbed condition as a standard for judging the completed Work.

H. Demolish and remove mock-ups when directed.

1.2 SCHEDULE OF FULL-SCALE MOCK-UP ASSEMBLIES (BUILDINGS)

A. Welcome Pavilions

1. Ticketing Pavilion

a. Ticket Pavilion Counter 6' Length including operable/fixed window Jamb, sill, and head conditions; GFRC full depth counter.
b. Ticket Pavilion Canopy 4' width minimum including fascia and all related attachments/fasteners, signage sample install, and roofing termination detailing at edge.
c. Ticket Pavilion Enclosure- 6' width minimum
d. Cladding/All enclosure conditions including full corner representing north and west façade, base detail, north and west standing seam roof edge with gutter.
e. Provide mock-up of primary structural HSS within enclosure assembly.
f. Provide all necessary cladding attachments and fasteners as documented in contract drawings.
g. Build mock-up surface representing design conditions providing all necessary structure engineered to support mock-up safely for visual evaluation.

2. Restroom Pavilion

a. Rest Room Pavilion GFRC Basin with Post/Pivot Panel full width 6' length including all visible supports, openings, operable portions, and plumbing fixtures
b. Rest Room Pavilion Enclosure- 6' width minimum

c. including full wall corner, base detail, door threshold, door header, parapet, and thru-wall scupper
d. Provide mock-up of primary wall framing in order to understand the curvature of the walls and its relation to cladding detailing.
e. Provide all necessary cladding attachments and fasteners as documented in contract drawings.
f. Build mock-up surface representing design conditions providing all necessary structure engineered to support mock-up safely for visual evaluation.

3. Group Canopy

a. Roof Edge Assembly 8' length with supports

B. Conservation, Fabrication and Maintenance Building

1. Enclosure 8' Width minimum

2. Cladding/All enclosure conditions: base detail, windowsill, window header, parapet, wall corner, downspout, and any typical cladding panel seams.

3. Provide mock-up of primary structural HSS within enclosure assembly.

4. Provide all necessary cladding attachments and fasteners as documented in contract drawings.

5. Build mock-up surface representing design conditions providing all necessary structure engineered to support mock-up safely for visual evaluation.

6. Steel Open Stair - Railing and Tread (3' length minimum full width)

7. Door Canopy - 3' width minimum

C. Administration Building

1. {schedule of mock-ups for Administration Building to be determined at a later date}

D. Pond Pavilion

1. {schedule of mock-ups for Pond Pavilion to be determined at a later date}

1.3 SCHEDULE OF FULL-SCALE MOCK-UP ASSEMBLIES (LANDSCAPE)

Provide mock-ups for all critical site and paving elements including:

A. Welcome Pavilions

1. light pole base and light pole

2. mountable and flush granite curb

3. chip and seal (sample areas must be larger than preliminary mock-ups provided)

4. ground exposed aggregate concrete paving (provide test grinding and jointing)

5. pea stone tree pits

6. bluestone paths and terrace

7. concrete tire stop

8. timber fence and boom gate

9. steel mesh fence
10. plastic mesh fence
11. splash pads at group canopy
12. granite steps
13. handrail

B. Conservation, Fabrication and Maintenance Building

1. chain link fence and rolling gate
2. concrete apron

C. Administration Building

1. {schedule of mock-ups for Administration Building to be determined at a later date}

D. Pond Pavilion

1. {schedule of mock-ups for Pond Pavilion to be determined at a later date}

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.

B. As part of the GMP, the CM in consultation with project architect and engineers, will provide the owner with a list of all required testing and inspections.

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.

1.4 QUALITY ASSURANCE

A. The testing laboratory will be qualified to the Owner's approval in accordance with ASTM E 329-20 "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. Hoists, stairs, and ladders.
3. Rodent control.
4. Construction fence.
5. Fire protection.
6. Temporary utilities.
7. Temporary toilets.
8. Temporary site access.
9. Water and snow control.
10. Environmental controls.
11. Site access.
12. Site Work expectations.
13. Personal site behavior.

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. Unless otherwise noted, pay all costs for temporary electrical power, temporary water, and temporary heating; provide metering as necessary.

D. 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 and pay all charges for installation and calls, including long distance calls.

2.3 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.

2.4 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.

2.5 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. Submit shop drawings of fence and gates for review of Architect and Owner. Paint the fence with two coats of an approved paint.

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

2.6 FIRE PROTECTION

A. Provide and maintain adequate fire protection, ready for instant use, distributed around the project. Fire extinguishers per OSHA guidelines.

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.

2.7 TEMPORARY HEAT AND VENTILATION

A. Provide temporary heat as required during construction to protect the work from freezing or frost damage, and as necessary to ensure suitable working conditions for the construction operations of all trades. 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 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.

2.8 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.

2.9 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.

2.10 TEMPORARY STAIRS, LADDERS, RAMPS, SIDEWALK BRIDGING AND 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.

D. Covered Walkway: Erect a structurally adequate, protective, covered walkway for passage of persons along adjacent public street. Coordinate with entrance gates, other facilities, and obstructions. Comply with regulations of authorities having jurisdiction.

1. Construct covered walkways using scaffold or shoring framing.

2. Provide wood plank overhead decking, protective plywood enclosure walls, handrails, barricades, warning signs, lights, safe and well drained walkways, and similar provisions for protection and safe passage.

3. Extend back wall beyond the structure to complete enclosure fence.

4. Paint and maintain in a manner approved by Owner and Architect.

5. For safety barriers, sidewalk bridges, and similar uses, provide minimum 5/8" thick exterior plywood.

6. Every effort should be made to schedule deliveries and movement of large vehicles either to the south of the site or when the Art Center is closed to the public. Necessary exceptions to this requirement must be scheduled with CM and coordinated with the owner.G. Construction personnel must log in and out with CM when on site for work. H. Construction personnel must park in designated construction parking when on site for work.

2.11 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.

2.12 TEMPORARY WATER SERVICE

A. 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.

B. 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.

2.13 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 within construction fence only.

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.

2.14 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.

2.15 SITE ACCESS (EX: ONLY ENTER FROM THE SOUTH OF THE SITE)

A. Every effort should be made to schedule deliveries and movement of large vehicles either to the south of the site or when the Art Center is closed to the public.

B. Necessary exceptions to this requirement must be scheduled with Whiting-Turner (who will then schedule with Storm King).

C. Construction personnel must log in and out with Whiting-Turner when on site for work.

D. Construction personnel must park in designated construction parking when on site for work. To be worked out with Whiting-Turner: Is all construction parking within the fence line or will construction personnel park in visitor parking areas? If so, we will need to limit hours and issue passes.

E. To be worked out with Whiting-Turner: How construction personnel enter and leave the site in personal vehicles when Storm King is open to the public.

F. To be worked out with Whiting-Turner: How construction-related vehicles move through the site when Storm King is open to the public.

2.16 WORK EXPECTATIONS

A. Contractors may not work on site without a signed contract and insurance form on file with Storm King.

B. Contractors must have appropriate OSHA certification and follow OSHA rules and regulations

C. No signage may be placed or affixed on construction fences or other public areas except as required by law or approved by Storm King. This includes Company Names, Logos/Marks, Phone Numbers.

D. All sanitation, rentals, garbage, etc. must remain within the construction fences.

E. No driving on grass or in areas marked “authorized vehicle only,” outside the construction fence areas, without prior permission from Storm King.

F. Construction personnel may not use Storm King vehicles, equipment, or tools.

G. Construction personnel may not use Storm King dumpsters or sanitation facilities.

2.17 BEHAVIORAL EXPECTATIONS (EX: NO SMOKING ON SITE),

A. No use of drugs or alcohol is permitted on the job site.

B. No smoking is permitted at Storm King.

C. No amplified music may be played while Storm King is open to the public or for a program or event.

D. To be worked out with Whiting Turner: Requirements re respectful language and behavior, including zero tolerance for harassment, on the construction site. This should include clothing and political speech.

E. Except as otherwise permitted, contractors may not make recordings (including photographs and video) of the worksite for personal use or public dissemination, including on social media.

F. Construction personnel who choose to visit Storm King Art Center during a break or before or after a shift when they are already onsite may do so when Storm King is open to the public and must abide by all visitor rules.

G. Construction personnel who choose to visit Storm King Art Center must be courteous, professional, and respectful to all visitors and employees.

H. Storm King will work with Whiting-Turner to develop a system of contractor family visit days and/or contractor passes so that construction personnel can visit Storm King with their families.

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 015639

TEMPORARY TREE AND PLANT PROTECTION

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 DESCRIPTION OF WORK

A. Protection of existing trees and plants from damage as a result of the Contractor's operations including, but not limited to:

1. Protection of existing natural woodlands.
2. Marking of clearing limits.
3. Tree protection fencing.
4. Tree armor.
5. Root pruning, construction pruning and vista pruning to improve views from the new building.
6. Root invigoration to promote root growth.

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. Section 310000, EARTHWORK; Excavation and backfill; Establishment of subgrade elevation.
2. Section 311000, SITE CLEARING AND GRUBBING Clearing and grubbing.
3. Section 329300, PLANTING: New plant material.

1.4 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 (ANSI):

Z133.1	Safety Requirements for Pruning, Trimming, Repairing, Maintaining and Removing Trees, and for Cutting Brush.

2. International Society of Arboriculture (ISA):

Guide	Guide for Establishing Values of Trees and Other Plants

3. National Arborist Association (NAA):

Ref. 1	Pruning Standards for Shade Trees

1.5 SUBMITTALS

A. Proposed methods, and schedule for effecting tree and plant protection shall be submitted for approval.

B. Proposed methods, materials, and schedule for root pruning, construction pruning, and tree fertilization shall be submitted for approval.

1.6 DAMAGE PENALTIES

A. Certain specimen trees adjacent to construction areas and in other key locations will be identified by the Owner and the Architect, and marked with red tags. Loss of any of these trees will result in fines assessed at $5,000 per tree. Damage to all other trees on the property will be assessed at the rate of $200 per inch caliper of the tree.

B. A fine of $1,000 will be levied against the Contractor for each incident of construction inside tree protection areas.

C. Damages to trees, shrubs, and other vegetation will be assessed by the Architect and Owner in accordance with the ISA Guide.

D. Trees or roots visibly damaged will cause the Owner to withold from the Contractor an assessed amount conforming to the requirements stipulated above for a period of two years. After that period the impact of the damage to any tree will be assessed accordingly.

E. If any trees or shrubs designated to be saved are damaged and replacement is required, a number and diameter of trees or shrubs of the same species and variety, as specified by the Owner and Architect, shall be furnished and planted by the Contractor. The total inch diameter of the replacement trees or shrubs shall equal the diameter of the tree or shrub to be replaced. The Contractor shall not be liable for any loss or damage which occurs while the Contractor is complying with instructions given by the Owner, Architect, or arborist working on the Project.

1.7 QUALITY ASSURANCE

A. Selective pruning and feeding methods shall conform to the applicable requirements of ANSI Z133.1.

B. Work of this section shall be completed by a professional ISA Certified Arborist with a minimum five years experience, who has successfully completed an exam and education program equal to the International Society of Arboriculture (ISA) Certification Program, sponsored by the International Society of Arboriculture 2009, P.O. Box 3129, Champaign, IL 61826 (217) 355-9411; Email: isa@isa-arbor.com.

C. Arborist shall have the following minimum qualifications:

1. Membership in:
   a. NAA – National Arborist Association
   b. ISA – International Society of Arborists
2. Meet state requirements for insurance.
3. Licenses for application and use of pesticides.

PART 2 PRODUCTS

2.1 TREE PROTECTION FENCING

A. Tree protection fencing shall be the following:

1. Galvanized chain link fencing, 6 ft. high.
2. Fabric shall be a good commercial quality of steel wire of 2 in. mesh and 11 gage.
3. Fittings shall be malleable iron casting, wrought iron forgings, or pressed steel and provided with pin connections. Equipment shall be designed to carry 100% overload.
4. Piping shall be steel conforming to ASTM A 120 except that pipe shall be unthreadedand untested for water pressure.

B. Stakes for fencing shall be 9 ft. galvanized steel posts, driven a minimum of 3 ft. into the ground, except above steam tunnel and vault locations where surface anchors shall be used. Posts shall be spaced 10 ft. o.c. maximum.

C. For fencing within the drip line of trees, surface mounted post anchors may be acceptable. Review with Architect and arborist and obtain written approval prior to installing. Post installation shall not damage tree root systems.

2.2 ACCESSORY MATERIALS

A. Mulch: Pine bark mulch

B. Tree Wound Paint: Bituminous based paint of standard manufactuere specifically formulated for protection of tree wounds from moisture and insect invasion.

C. Tree Armor:
1. Wood: SPFA utility grade, 2x4.
2. Wire: Annealed steel wire, 16 gage minimum.

D. Critical root zones shall be protected with AlturnaMats, 1/2" thick recycled polyethylene mats capable of supporting vehicles and equipment weighing up to 60 tons, manufactured by AlturnaMats, Inc., 701 E. Spring Street, Mailbox #9, Titusville, PA 16354 • Phone: 888.544.6287 • Fax: 866-723-2903 , or approved equal.

2.3 ROOT PRUNING

A. Mulch materials shall be as specified under Section 329300, TREES PLANTS, ANDGROUND COVERS.

B. Liquid fertilizer to be applied to root pruned and construction pruned trees shall be PetersM 77 Sequestered-Chelated Soluble Fertilizer manufactured by W.R. Grace and Co., Cambridge, MA 02140, Gold Start Liquid Fertilizer, manufactured by Nutra-Flo Company, 1919 Grand Ave, Sioux City, IA 51106-5708; Phone: 712-277-2011; 800-831- 4815; Fax: 712-279-1946; Agro- Culture Liquid Fertilizer, manufactured by Agro-Culture Liquid Fertilizers, 3055 W. M-21, P.O. Box 150, St. Johns, Michigan 48879; 1-800-678- 9029, or approved equal. Liquid fertilizer shall be approved by Certified Arborist.

C. Dormant oil spray shall be a dormant miscible spray equal to Sunspray, Scalecide, or Volck Oil.

D. Insecticide shall be Isotox manufactured by Ortho; QuickPRO, manufactureed by Monsanto; LESCO Sevin Brand SL, #019106, manufactured by LESCO, or approved equal. Insecticide shall be approved by Certified Arborist.

PART 3 EXECUTION

3.1 INSTALLATION OF FENCING

A. Prior to start of demolition work and clearing and grubbing operations, tree protection fencing shall be installed in accordance with the following:

1. Fencing shall be installed at the tree protection areas indicated on the Drawings.
2. Fencing shall be installed at the drip line of trees to be protected, unless otherwise approved by the Architect.

B. Post installation must avoid underground utilities. Tree protection fencing located over steam tunnel/vault locations shall be installed using surface anchors. No poles or stakes shall be driven into the ground at these locations.

3.2 PROTECTION FOR EXISTING TREES TO BE PRESERVED:

A. All trees to be preserved on the property shall be protected against damage from construction operations.

1. Includes associated understory.

B. Only those trees located within the limits of improvements to be constructed as indicated, shall be removed.

1. All trees to remain shall be flagged for review after the location of improvements to be constructed are staked in the field.
2. Any tree to be removed shall be reviewed by the Architect and Owner for approvalprior to removal.
3. Trees to be preserved, removed or newly planted are represented graphically and differentiated from existing trees.
4. Obtain approval of installation of tree barricade fencing from Owner and Architectprior to the initiation of any removal of vegetation and construction.

C. Erect fencing and armor protection prior to beginning any clearing, demolition or construction activity, and unless otherwise instructed, maintain in place until constructionis completed.

1. Obtain approval of installation of tree barricade fencing from Owner and Architect prior to the initiation of any removal of vegetation and construction.
2. Tree protection barricade shall be erected at the dripline; in extreme circumstances and with the approval of the Architect, fencing may be located at the edge of the root protection zone.
3. Trees immediately adjacent to and within one hundred feet (100) of any construction activities are to be protected by barricade fencing; subject to approval of the Architect and Owner.
4. Trees exposed to construction activity within the dripline or within twenty-five (25) feet of any construction activity are to have trunks protected with tree armor in addition to barricade fencing.
5. The tree protection barricade shall be placed before any excavating or grading is begun and maintained in repair for the duration of the construction work unless otherwise directed.
6. No material shall be stored or construction operation shall be carried on within the tree protection barricade.
7. Tree protection barricade shall remain until all work is completed.
8. Remove tree protection barricade at commencement of finish grading.
9. Remove tree armor immediately prior to Substantial Completion.

D. Protect tree trunk with tree armor to a height of 8' or to the limits of lower branching (whenexposed to construction activity within the drip line) with 2x4's butted side to side completely around trunk.

1. Wire wrap, do not nail, around trees.

E. Protect trees that are to remain, whether within barricade fencing or not, from the following:

1. Compaction of root area by equipment or material storage; construction materials shall not be stored closer to trees than the farthest extension of their limbs (dripline).

2. The proposed finished grade within the root protection zone of any preserved tree shallnot be raised or lowered more than three (3) inches.
   a. Retaining methods can be used to protect and/or provide lateral support to the area outside the root protection zone.
3. Trunk damage by moving equipment, material storage, nailing or bolting.
4. Strangling by tying ropes or guy wires to trunks or large branches.
5. Poisoning by pouring solvents, gas, paint, etc., on or around trees and roots.
6. Cutting on roots by excavating, ditching, etc.
   a. Prior to excavation within the tree drip lines or the removal of trees adjacent to other trees that are to remain, make a clean cut between the disturbed and undisturbed root zones with a rock saw or similar equipment to minimize root damage.
   b. Refer to EXCAVATION AROUND TREES paragraph for additional information.
7. Damage of branches by improper pruning.
8. Drought from failure to water or by cutting or changing normal drainage pattern past roots. Contractor shall provide means as necessary to ensure positive drainage.
9. Changes of soil pH factor by disposal of lime base materials such as concrete, plaster, lime treatment at pavement subgrade, etc. When installing concrete adjacent to the root zone of a tree, use a minimum 6 mil. plastic vapor barrier behind the concrete to prohibit leaching of lime into the soil.
10. Do not cut roots 3/4" in diameter or over without approval of Owner's Representative. All excavation and earthwork within the RPZ of trees shall be done by hand.
11. Protect all existing trees near areas to be stabilized from underground contaminationsby placing a 6 mil. Plastic film barrier along exposed vertical cut extending a minimum12" into undisturbed subgrade below depth of stabilization.
12. No vehicular traffic shall occur within the drip line of any tree; including parking of vehicles.
13. No soil shall be spread, spoiled or otherwise disposed of under any tree within the RPZ.

F. Any damage done to existing tree crowns or root systems shall be repaired by the Arboristto the satisfaction of the Architect and Owner's Representative.

1. Broken branches shall be cut cleanly.
2. Any roots cut shall be cut cleanly with a saw other means approved by the Architectand Owner's Representative.

G. Damages to trees caused through negligence of Contractor or his employees will beassessed by Owner and Project Arborist as described in Paragraph 1.05.

3.3 ROOT PROTECTION ZONE:

A. The root protection zone (RPZ) is measured with a radius from the trunk 10'.

1. No disturbance shall occur closer to the tree than one-half the radius of the RPZ or within five (5) feet of the tree whichever is greater.

3.4 ROOT PROTECTION ZONE IMPACTS:

A. Those trees to remain which have some encroachment on their root protection zone shallhave the following maximum allowable impacts:

1. Minimum Protection Criteria 'A': No disturbance of natural grade, e.g. trenching or excavation, can occur closer to the tree than one-half the radius of the RPZ or within five (5) feet of the tree whichever is greater.
2. Minimum Protection Criteria 'B': No cut or fill greater than three (3) inches will be located closer to the tree trunk than ½ the RPZ radius distance.

B. Trees impacted shall have a minimum of a six (6) inch layer of mulch placed andmaintained over the root protection zone and the undisturbed area within the dripline.

1. Immediate pruning and fertilization shall occur per the pruning and fertilizationsections of this specification.
2. Provide water in a slow drip manner to impacted trees as approved by the Architectand Owner's Representative.
3. Provide water to apply equivalent to 1 inch once per week to deeply soak in over thearea within the dripline of the tree during periods of hot, dry weather.
4. Spray tree crowns periodically to reduce dust accumulation on the leaves.

3.5 EXCAVATING AROUND TREES

A. Excavate within the dripline of trees only where required and when absolutely necessary.

1. Any excavation within the RPZ of trees shall be under the direction of the Arborist.
2. Arborist shall be at site at all times while excavation is occurring within the RPZ.
3. Air spade all removals within the RPZ.
4. Refer to ROOT PROTECTION ZONE (RPZ).

B. When excavating for new construction is required within the RPZ, air spade and hand excavate to minimize damage to root systems.

1. Use narrow tine spading forks and comb soil to expose roots.
2. Relocate roots back into backfill areas wherever possible.
3. If large main lateral roots are encountered, expose beyond excavation limits asrequired to bend and relocate without breaking.
4. If root relocation is not practical, clean cut roots using sharp ax approximately three (3) inches back from new construction.

C. Where existing grade is above new finish grade, carefully excavate within the dripline tothe new finish grade.

1. Carefully hand excavate an additional six (6) inches below the finish grade.
2. Use narrow tine spading forks to comb the soil to expose the roots, and prune the exposed root structure as recommended by the Arborist.

3. Keep the exposed roots damp.
4. Treat the cut roots as specified and as recommended by the Arborist.
5. After pruning and treatment of the root structure is complete, backfill to finish gradewith eight (8) inches of approved plant mix, or structural soil.

D. Where noted on plan, use airspade to expose roots for required cutting to accomidate hardscape elements. Architect to verify all cuts prior to proceeding.

E. Temporarily support and protect roots against damage until permanently relocated and covered with recommended landscape material.

3.6 ROOT PRUNING

A. Where construction will be in close proximity to existing trees designated to remain, roots shall be pruned. Proximity shall be as determined in the field by the Architect.

B. Root pruning is the physical cutting of tree roots to minimize root damage and promote healing. Suitable means for root pruning include trenching, vibrating plow, stump grinder. Any method which tears roots or disturbs the soil beyond the grading limit is unacceptable.

C. Tree to be root pruned shall be root pruned to a depth of 24 in. by means of a trencher or other approved means.

D. Backfill root pruning trench with existing soil mixed with peat moss or well-rotted sawdust to a mixture of approximately 75% soil and 25% humus. Tamp lightly to set soil

E. Apply mulch to a depth of 4 in. to 6 in. at minimum 10 ft. to 15 ft. radius around tree to reduce compaction of roots.

3.7 GOVERNING STANDARDS:

A. Work procedures will be guided by the current provisions of the American NationalStandard Institute. Complete detail of the provisions are to be found in the references listed. The two basic objectives of the pruning operation shall include:

1. Hazard Reduction Pruning: Hazard reduction pruning shall be completed to remove visible hazards in a tree. Hazard pruning shall consist of one or more of the maintenance pruning types.
2. Maintenance Pruning: Maintenance pruning shall be completed to maintain and improve tree health and structure and includes hazard reduction pruning.

3.8 MAINTENANCE PRUNING TYPES:

A. Both hazard reduction pruning and maintenance pruning shall consist of one or more of the following pruning types:

1. Crown Cleaning: Crown cleaning shall consist of the selective removal of one or more of the following items: dead, dying, or diseased branches, weak branches, water sprouts and stubbed branches.
2. Crown Thinning: Crown thinning shall consist of the selective removal of branches to increase light penetration, air movement, and reduce weight.
3. Crown Raising: Crown raising shall consist of the removal of the lower branches of a tree to provide clearance.
4. Crown Reduction, or Crown Shaping: Crown reduction shall consist of decreasing the height and/or spread of a tree.
5. Vista Pruning: Vista pruning shall consist of selective thinning of framework limbs or specific areas of the crown.
6. Crown Restoration: Crown restoration pruning shall improve the structure, form and appearance of a tree which has been severely headed, vandalized, storm damaged or improperly pruned.

3.9 UTILITY PRUNING:

A. Utility pruning shall consist of one or more of the following items:

1. Trees Underneath: Pruning trees growing directly under and growing into the facility/utility space.
2. Trees Along Side: Pruning of trees growing directly along side and growing into or toward the facility/utility space.

3.10 SCHEDULE

A. All of the pruning type(s) as applicable are required at each tree. All pruning shall be completed to remove branches/laterals 1/8 inch and greater. All prunning to be completed before commencement of demolition. .

1. Height clearance:
   a. Pedestrian Areas: 8 feet height clearance from grade unless directed otherwise by Architect and Owner.
   b. Vehicular Areas: 13'-6" height clearance from top of paving unless directedotherwise by Architect and Owner.

3.11 CROWN IMPACTS

A. Trees impacted by construction shall be limited to a maximum of 30 percent of the viable portion of a tree's crown removed as approved by the Architect and Owner's Representative. Removal of more than 30 percent of the viable portion of a tree's crown will necessitate the tree's removal and replacement at the Contractor's expense.

1. Replacement shall be governed at the ratio of 1 inch of new tree per inch of tree removed up to trees of size less than 24" caliper. For trees 24" caliper and greater the ratio shall be 3 inches per new tree per inch of tree removed.
2. Replacement trees are to have a one (1) year warranty; refer to Section 329300,TREES, PLANTS, AND GROUNDCOVER.

3.12 APPROVAL

A. No major limbs or structure will be cut or removed without prior approval of the Architect and Owner's Representative.

3.13 STERILIZATION

A. All tools used will be sterilized with Clorox Bleach, or approved equal, prior to use and between each tree.

B. Residue from sterilization operation shall be diluted so as not to damage any vegetation.

C. At trees known to be diseased and where there is danger of transmitting that disease, tools are to be disinfected after each cut.

3.14 PAINT CUTS:

A. Paint cuts more than 1 inch in diameter with an approved tree wound paint on trees.

1. Paint cuts within 30 minutes after cutting.

3.15 FERTILIZATION OF PRESERVED TREES

A. All existing trees to be preserved impacted by construction activities taking place withinthe dripline, including but not limited to trenching and grading, shall be fertilized.

B. Feeding of existing trees to be impacted by construction shall be accomplished in accordance with the following specifications:

1. Feeding shall be completed prior to construction of permanent improvements adjacent to all trees including site fill or paving including trenching operations.
2. Liquid tree fertilizer applied with a standard hydrant sprayer at a pressure of 100 to 200 psi shall be injected in slightly slanted holes approximately twelve (12) inches in depth.

3. Concentration of suspension to be forty (40) pounds of fertilizer for trees in each 100 gallons of water. Application rate: six (6) pounds of actual nitrogen per 1,000 square feet of area under drip-line.
4. Holes are to be made in concentric circles and 3' on center around the tree with the last ring located at the dripline of the foliage of the trees.
5. Area beneath the dripline of the trees is to be well watered after the fertilization is placed.

3.16 ROOT INVIGORATION

A. Trees with root zones displaying deteriorating soil conditons due to turf managementpractices, soil compaction, lack of organic matter in the soil, and lack of nutrients shall be identified by the Project Arborist and receive a root invigoration program. Root invigoration incorporates organic matter, fertilizer, and mycorrhizal fungi while reducing soil compaction and aerating the soil,promoting root growth.

B. Root invigoration shall be accomplished by implementing the Bartlett Root Invigoration Program as follows:

1. Site evaluation, tree evaluation and soil sampling. The landscape and affected trees are examined to make certain that they are suitable candidates for the service. Not all declining trees will respond to this treatment. Soil analysis provides information on the current nutrient, pH and organic matter levels as well as soil penetrability/density.
2. Program recommendations. Either Basic or Complete Root Invigoration Program may be recommended depending on results of the diagnostic tests, tree condition and your landscape goals. A Basic Root Invigoration (Figure 1) includes soil conditioning only around the trunk of the tree. A Complete Root Invigoration (Figure 2) conditions the soil around the trunk and in segments throughout the critical root zone.
3. Irrigation. Irrigation is required prior to and after treatment during periods of drought.
4. Fertilizer Application. Bartlett's unique Soil Rx Prescription Fertilization matches fertilizer to your soil and tree needs and provides the greatest benefits with the least environmental impact.
5. Soil Conditioning. On the day of treatment a crew of one or two will arrive with a largeair compressor and the materials that will be incorporated into the soil. They will cultivate the soil using an air spade, designed to till the soil without disturbing the roots. Following this operation, organic matter, fertilizer and mycorrhizal fungi will be incorporated into the treatment zone.
6. Mulching. The work area will be covered with mulch at the end of the process. Mulch depth should be maintained at 2 to 4 inches for optimum response. If it is not desirable to mulch the area, it can be seeded in ground cover, planting grass is not recommended. Turf will inhibit tree root development and make the treatment much less beneficial.
7. Root Diseases. If root disease is suspected of playing a role in the tree decline, a root sample will be collected for additional diagnostic testing. Treatment recommendations can be provided at a later date, if required.

3.17 MULCH

A. Mulch base of all existing trees four (4') feet radius with 3 " deep mulch layer.

1. If existing trees are grouped, the entire area is to be mulched in between the trees.

B. Mulch base of all existing trees impacted by construction activities within RPZ with 3" deep mulch layer.

1. If existing trees are grouped, the entire area is to be mulched in between the trees.

3.18 CLEANUP

A. Wood and debris shall become property of the Contractor and shall be removed from the site. Cost of disposal to be paid by Contractor.

B. If acceptable to Owner, wood from tree removal and pruning activities can be double shredded/grinded and used on site as mulch at locations as approved by Architect and Owner.

3.19 REMOVAL OF PROTECTION

A. All protection shall remain in place throughout the construction period. Remove protection devices only after written permission has been granted by the Architect.

END OF SECTION 015639

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 and applicable Union rules 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 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. 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.

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

G. 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.

H. 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 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. 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 digitally. 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.

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 and submit in electronic format.

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. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
o. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
p. Clean ducts, blowers, and coils if units were operated without filters during construction.
q. 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.
r. 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 017700.

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: Submit in electronic format.

1.6 MANUAL FOR MATERIALS AND FINISHES

A. Submit PDF 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 PDF 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. Operating 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. Operating 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 018900
SITE CONSTRUCTION PERFORMANCE REQUIREMENTS

PART 1 – GENERAL

1.01 DESCRIPTION

A. This Section specifies the general requirements for the site work included in the Contract.

B. These requirements supplement those contained in the Standard General Conditions of the Construction Contract and their Supplemental Conditions.

C. References are included in this Section to Articles of the General Conditions to call the Contractor's attention to frequently needed requirements.

1.02 PERMITS

A. Unless otherwise provided in the Supplementary Conditions, the Contractor shall obtain and pay for all construction permits and licenses. The Owner shall assist Contractor, when necessary, in obtaining such permits and licenses. The Contractor shall pay all charges and inspection fees necessary for the prosecution of the Work and shall pay all charges of utility owners for connections to the Work.

1.03 LAWS AND REGULATIONS

A. Contractor shall give all notices and comply with all laws and regulations applicable to furnishing and performance of the Work.

B. If the Contractor performs any work that is contrary to laws or regulations, the Contractor shall bear all claims, costs, losses and damages caused by, arising out of or resulting therefrom.

1.04 UTILITIES

A. Shown or Indicated: The information and data shown or indicated in the Contract Documents with respect to existing underground facilities (utilities) at or contiguous to the site is based on information and data furnished to Owner or Engineer by the owners of such underground facilities (utilities) or by others.

1. The Owner and Engineer shall not be responsible for the accuracy or completeness of any such information or data; and
2. The cost of all of the following will be included in the Contract and Contractor shall have full responsibility for: (i) reviewing and checking all such information and data; (ii) locating all underground facilities (utilities) shown or indicated in the Contract Documents; (iii) coordination of the Work with the owners of such underground facilities (utilities) during construction; and (iv) the safety and protection of all such underground facilities (utilities) and repairing any damage thereto resulting from the Work.

B. Not Shown or Indicated: If an underground facility (utility) is uncovered or revealed at or contiguous to the site which was not shown or indicated in the Contract Documents, the Contractor shall, promptly after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency), identify the owner of such underground facility (utility) and give written notice to that facility (utility) owner and to Owner and Engineer. Engineer will promptly review the underground

facility (utility) and determine the extent, if any, to which a change is required in the Contract Documents to reflect and document the consequences of the existence of the underground facility (utility). If the Engineer concludes that a change in the Contract Documents is required, revised plans and specifications will be issued to reflect and document such consequences. During such time, the Contractor shall be responsible for the safety and protection of such underground facility (utility).

C. Contractor shall notify all municipal agencies and public and private utility companies owning or operating utilities, of proposed work affecting the utilities, or agencies.

D. Contractor shall give written notification within the time period required by the agency or company for advance notification. A copy of the notification shall be furnished to the Engineer.

E. Contractor shall notify "DIG SAFE" before commencing any work in the vicinity of existing subsurface utilities.

F. Contractor shall secure in-place existing utilities whose support is affected by the work and cooperate and assist the agency or company operating the utility in maintaining the utility services. Contractor shall correct any damage to the utilities caused by construction operations by repair or replacement, as required by the utility owner. When the repair or replacement is made by the utility owner, Contractor shall pay all costs assessed by the utility owner for the work.

G. If the existing utilities are found to conflict with the proposed work, the Contractor shall protect and maintain the utilities and take measurements to determine the location, type and dimensions of the utility. The information shall be furnished to the Engineer who will determine the changes required in the proposed work or existing utilities to resolve the conflict as soon thereafter as is reasonable.

H. Contractor shall verify the location, size, invert elevation and type of existing facilities at all points of connection prior to ordering new utility materials.

1.05 SOILS INFORMATION

A. A geotechnical report on site soil conditions has been prepared for the Owner. Refer to Section 310000 – EARTHWORK for information about and use of the geotechnical report.

B. The geotechnical report and the soils data are furnished to Contractor for informational purposes only and are specifically not a part of these Contract Documents. The Owner does not guarantee that the information is representative of all soils, rock, and other materials that may be encountered on the site.

C. Contractor may make additional subsurface explorations upon written request to, and upon approval by, the Owner at no additional cost to the Owner.

1.06 SOIL SUPPORT

A. Contractor shall furnish and install excavation soil support devices or use soil strengthening techniques required to perform excavations in accordance with the current requirements of the U.S. Department of Labor, Occupational Health & Safety Administration and all federal, state, and municipal laws and regulations.

1.07 REFERENCE STANDARDS

A. References are made to technical societies, organizations and groups using the following abbreviations. All work so referred shall conform to the current edition of the referenced standard.

306R	Cold Weather Concreting
AASHTO	American Association of State Highway Transportation Officials
ACI	American Concrete Institute
ACOE	United States Army Corps of Engineers
AGC	Associated General Contractors of America
ANSI	American National Standards Institute
AOAC	Association of Official Agricultural Chemists
ASTM	American Society for Testing and Materials
AWPA	American Wood Preservers Association
AWWA	American Water Works Association
NEMA	National Electrical Manufacturers Association
NEWWA	New England Water Works Association
OSHA	Occupational Safety and Health Administration
UL	Underwriters Laboratory

1.08 TRAFFIC MAINTENANCE

A. Contractor shall maintain access to the site and through the work zones for personnel and vehicles of emergency services, utility agencies, inspection services, and others authorized to enter, move about and work on the site.

B. When work is required on public roadways, Contractor shall furnish, install, maintain, and remove all signs, drums, barricades, steel plates, and other devices required by the federal or state government or municipality to maintain and protect pedestrians and vehicular traffic.

C. Protective measures shall be installed at site access points to prevent mud and other debris from being deposited on the public roadways by construction traffic. The public roadways shall be swept as required to remove any deposits.

1.09 STATE AND LOCAL REFERENCE STANDARDS

A.

Building Code	New York State Building Code
Fire Code	New York State Fire Code
NYSDEC	New York State Department of Environmental Conservation
NYSDOT	NYSDOT Design Standards

END OF SECTION 018900

SECTION 024113

SELECTIVE SITE DEMOLITION AND REMOVALS

PART 1 GENERAL

1.00 GENERAL PROVISIONS

A. Attention is directed to the PROCUREMENT AND CONTRACTING REQUIREMENTS and all Sections within DIVISION 01, GENERAL REQUIREMENTS, which are made a part of this Section of the Specifications.

1.01 SUMMARY

A. Provide all equipment and do all work necessary to demolish and/or remove the structures indicated and prepare the site as indicated on the Drawings.

1.02 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 010000, GENERAL REQUIREMENTS; Temporary Tree and Plant Protection.
2. Section 311200, SITE CLEARING; Clearing and grubbing, stripping and stockpiling topsoil and tree removal.
3. Section 312000, EARTHWORK; Excavation and backfill.
4. Section 329600, TRANSPLANTING.

1.03 SUBMITTALS

A. The following shall be submitted:

1. Permits and notices authorizing building demolition.
2. Certificates of severance of utility services.
3. Permit for transport and legal disposal off-site of demolition material and debris.
4. Demolition procedures and operational sequence for review and acceptance by Architect.
5. Location plan of staging areas and schedule for moving staging equipment into those areas shall be submitted for Architect's approval prior to mobilization and related site preparation operations.
6. A list of all site operations and programs to be accommodated during construcrtion period.

B. Predemolition photographs: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by building demolition operations. Submit before the Work begins.

1.04 QUALITY ASSURANCE

A. Predemolition Conference: Conduct conference at Project site to comply with requirements in Section 010000, GENERAL REQUIREMENTS. Review methods and procedures related to selective demolition including, but not limited to, the following:

1. Inspect and discuss condition of construction to be selectively demolished.
2. Review structural load limitations of existing structure.
3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Review areas where existing construction is to remain and requires protection.

1.05 PROTECTION

A. Do not interfere with use of adjacent buildings. Maintain free and safe passage to and from.

B. Prevent movement or settlement of adjacent structures. Provide and place bracing or shoring and be responsible for safety and support of structures. Assume liability for such movement, settlement, damage, or injury.

C. Cease operations and notify Architect immediately if safety of adjacent structures appears to be endangered. Take precautions to properly support structures. Do not resume operations until safety is restored.

D. Prevent movement, settlement or collapse of adjacent services, sidewalks, driveways and trees. Assume liability for such movement, settlement, or collapse. Promptly repair damage at no cost to the Owner.

E. Provide, erect, and maintain street boardings, sidewalk shed, barricades, lighting, and guardrails as required to protect general public, workers, and adjoining property.

1.06 EXISTING CONDITIONS

A. Arrange and pay for disconnecting, removing, capping, and plugging utility services. Disconnect and stub off. Notify the affected utility company in advance and obtain approval before starting this work.

B. Place markers to indicate location of disconnected services. Identify service lines and capping locations on Project Record Documents.

C. The Owner agrees to remove all asbestos from structures to be demolished. Before Construction Documents are issued to the Contractor for construction, the Owner will certify to the Architect and Contractor that the site is free of asbestos. If asbestos is found on the site and recognized as such, all work will cease without penalty to the Contractor or Architect so that the Owner can take appropriate steps for its removal.

1.07 MAINTAINING TRAFFIC

A. Do not close or obstruct roadways without permits.

B. Conduct operations with minimum interference to public or private roadways.

1.08 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.09 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

PART 2 PRODUCTS

2.01 SALVAGING

A. Materials indicated on the Drawings or designated in the field by the Owner to be salvaged shall be carefully removed and delivered to a location on site to be determined by the Owner.

B. Mechanical and electrical items to be salvaged shall be protected from the weather.

C. Storage requirements during construction.- storage site/location to be determined and reviewed by Architect and Owner.

PART 3 EXECUTION

3.01 DEMOLITION

A. Structures indicated to be removed shall be completely removed including foundations, except when approved by the Architect, to a minimum of 4 ft. below finished grade for graded areas.

B. Pump out buried tanks located outside building proper. Remove tanks and service piping from site or to the satisfaction of the Architect. Fill tanks with sand or fine gravel and cover with fill.

C. Remove from site, contaminated, vermin infested, or dangerous materials encountered and disposed of by safe means so as not endanger health of workers and public.

D. Backfill areas excavated as a result of demolition. Use backfill material specified in Section 312000, EARTHWORK.

E. Rough grade areas affected by demolition and leave areas level, maintaining grades and contours of site.

F. Site Access and Temporary Controls: Conduct demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities

having jurisdiction.

2. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.

3.02 ABANDONED PIPES - DRAINS AND SEWERS

A. Contractor shall arrange with appropriate utility company for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.

1. Verify that utilities have been disconnected and capped before proceeding with site clearing.

B. Drain and sewer pipes indicated to be abandoned shall be completely filled with an 8 in. thick mortar jointed masonry bulkhead. If a pipe indicated to be abandoned and plugged appears to be in active service, it shall not be plugged, and the Architect shall be notified.

C. Other utility pipes shall be cut and capped outside the excavation and abandoned piping removed from the site.

D. Frames, grates, covers, traps, and other castings shall be salvaged.

3.03 REMOVALS

A. Materials indicated on the Drawings or designated by the Architect in the field to be removed shall be dismantled, removed, and legally disposed of off-site or stockpiled as indicated on the Drawings.

B. Areas formerly occupied by structures shall be regraded to conform with surrounding topography following demolition.

3.04 SALVAGEABLE MATERIALS

A. Materials indicated on the Drawings or designated by the Architect in the field to be salvaged shall be carefully removed, protected from damage, and put in temporary storage as follows:

1. Salvaged material shall be stockpiled on-site in an area designated by the Owner.

3.05 DEMOLITION

A. Existing structures indicated on the Drawings to be removed, shall be completely dismantled and removed from the site.

1. Structures not indicated on the Drawings for removal but conflict with proposed site improvements shall be reviewed with Architect prior to start of any removal operations.

B. Areas formerly occupied by structures shall be regraded to conform with surrounding topography following demolition.

C. Pump out buried tanks located outside building proper. Remove tanks and service piping from site or to the satisfaction of the Architect. Fill tanks with sand or fine gravel and cover with fill.

D. Remove from site, contaminated, vermin infested, or dangerous materials encountered and disposed of by safe means.

E. Backfill areas excavated as a result of demolition. Use backfill material specified in Section 312000, EARTHWORK.

F. Rough grade areas affected by demolition and leave areas level, maintaining grades and contours of site.

G. Site Access and Temporary Controls: Conduct demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
2. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.

3.06 PROTECTION OF EXISTING STRUCTURES AND UTILITIES

A. Existing memorials, fences, stone walls, catch basins, structures and utilities shall be suitably protected from damage.

3.07 PAVEMENT AND CURB REMOVAL

A. Where pavement and/or curb to be removed abuts pavement and curb to remain, a neat, straight saw cut shall be made with a concrete power saw.

1. Pavement and/or curb removal shall include removal of subbase as required to accommodate proposed construction materials.

3.08 SITE RESTORATION

A. Below-Grade Areas: Rough grade below-grade areas ready for further excavation or new construction.

B. Site Grading: Uniformly rough grade area of demolished construction to a smooth surface, free from irregular surface changes. Provide a smooth transition between adjacent existing grades and new grades.

3.09 PROTECTION OF PROPERTY TO REMAIN

A. The Contractor's attention is directed to Section 312000, EARTHWORK for protection of

utilities to remain, and for the protection of existing trees, fences, etc.

3.10 DISPOSAL OF MATERIALS

A. Material resulting from demolition and not scheduled for salvaging shall become the property of the Contractor and shall be suitably disposed of off-site. Disposal shall be performed as promptly as possible and not left until the final clean up.

B. Debris, rubbish, and other material shall be disposed of promptly and shall not be left until final cleanup of site.

END OF SECTION

SECTION 033000

CAST-IN-PLACE CONCRETE

REVIEW AND UPDATE CONCRETE PER THE FOLLOWING DISCUSSIONS:
-ABILITY TO USE FLYASH FOR SUSTAINABILITY
-SEALER FOR SLAB ON GRADE TO PROTECT FROM OILS ETC
-WATERPROOFING ADMIXTURE FOR TANK

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. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:

1. Substructure.
2. Slabs-on-ground.
3. Superstructure.
4. Concrete toppings, including housekeeping pads and non-structural fill.

B. Related Sections include the following:

1. Division 05 Section “Structural Steel Framing” for steel framing and post-installed concrete anchors.
2. Division 03 Section “Polished Concrete Finishing”
3. Division 03 Section “Exposed Aggregate Concrete Pavement”

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, slag cement, and silica fume; subject to compliance with requirements.

1.4 SUBMITTALS

A. General:

1. Review of submittals is of a general nature only, and the responsibility for conformance with intent of drawings shall remain with the Contractor. Review does not imply or state that the fabricator has correctly interpreted the construction documents.
2. All submissions shall be in accordance with the submission schedule developed and agreed between the Architect and Contractor at the commencement of the project. Submission shall include dates of order and delivery of materials to the shop and the site.
3. Shop drawing schedule shall allow adequate time for reviews. Reinforcing steel shall not be fabricated or placed before the shop drawings have been reviewed by the Architect and returned.

B. Dimensions:

1. While the position of most concrete members is directly defined on the Structural Drawings, there are instances where reference shall be made to Architectural or other Drawings to

deduce a dimension. The Contractor shall be responsible for such dimensional coordination and cross-referencing.

2. With the position of concrete members thus fixed, the Contractor will still need to deduce and compute other dimensions that are derivative from the basic dimensions. These may include, but are not limited to, true distance between work points, and the lengths and orientation of members. Such derivation of dimensions is the responsibility of the Contractor.
3. To ensure accuracy of these dimensions, the Contractor shall produce layout drawings as well as detailed steel reinforcement Shop Drawings. Although they will not be checked, these layout drawings are to be submitted at the same time as the relevant shop drawings.

C. Product Data: For each type of product indicated, including ICC-ES for mechanical couplers.

D. Design Mixtures: Each concrete mix design to be used on the project shall be reviewed and approved by the Testing Agency and Architect prior to concrete being delivered to site. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. For each concrete mixture, the following information shall be included: where the mix is to be used, all materials and admixtures including their source and proportions in the mix; Water content, water-to-cement ratio, slump, and aggregate grading; whether the mixture is appropriate for pumping; and total chloride content.
2. Provide shrinkage test results for mixes with shrinkage criteria showing that mix meets performance criteria. The mix design number must match with the mix design number shown on the test data.
3. Indicate compressive strength and method used to determine strength. The compressive strength of the concrete shall be proportioned per ACI. Include all calculations and tests required by ACI 318 Section 5.3 and 5.4. Laboratory test data must be submitted along calculations that show with each mix design meets the strength requirement. Mix design number must match the mix design number shown on the test data. Include all test results or past history back up data specific as part of the submittal. Test results within the past two years shall be used to indicate performance in accordance with past history.
4. Indicate amounts of mixing water to be withheld for later addition at Project site.
5. Each mix shall be stamped and signed by a Professional Engineer licensed in the State of New York.

E. Steel Reinforcement Shop Drawings: Placing drawings in accordance with SP 66 that detail fabrication, bending, and placement. Direct copies of the contract documents are not acceptable as a submission from the Contractor.

1. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement. Include any welding to be done.
2. Shop drawings shall make it clear where each bar is located. Beams, grade beams and walls shall be shown in elevation. On elevations show locations of sleeves and penetrations.
3. Check architectural, structural, mechanical, and electrical and other contract documents for anchor bolt schedules and locations, anchors, inserts, conduits, sleeves, and any other items which are required to be cast in concrete, and make necessary provisions as required so that reinforcing steel will not interfere with the placement of such embedded items.

4. Show all areas of congestion. Identify where reinforcing steel will interfere with the placement of embedded items such as anchor bolts, anchors, inserts, conduits, sleeves and any other items which are required to be cast in concrete.

F. Submit schedule of concrete placement operations before commencing Work.

G. Show on one or more plans and/or elevations, locations of construction, contraction and expansion of joints, slab edges, curbs, equipment pads, depressions, sleeves and openings.

H. Formwork: Prepared by or under the supervision of a qualified professional engineer, registered in the State of New York, detailing fabrication, assembly, and support of formwork.

1. Design Criteria:

a. Design of concrete formwork, shoring, reshoring and bracing shall be the sole responsibility of the Contractor and shall conform to Code requirements and shall be in accordance with the recommendations of ACI 347. Forms shall provide the required shape and dimensions specified on the Documents.

b. Provide forms complete and of such strength and adequately braced so as to prevent any spreading, shifting or settling when concrete is placed to ensure finished concrete surfaces of the required tolerances.

c. Forms shall be tight to prevent leakage or washing out of cement mortar from concrete.

d. Bolts, rods, and other devices when used for internal ties and spreaders shall be of such construction that when the forms are removed, no metal shall be within 1 inch of the exterior concrete surfaces or within 1/2 inch of interior concrete surfaces.

2. Shop Drawing Requirements:

a. Shop Drawings shall show location and layout of construction joints, reveals, slab edges, form joints, sleeves, openings, locations of tie holes or plugs, location of embedded items and blockouts, and all related details affecting Architectural quality.

b. Shop Drawings will show dimensioned location to the face of formwork for walls, beams, columns, slab edges, slab depressions, etc.

c. Formwork details affecting Architectural finish quality shall be reviewed by the Architect.

d. Indicate where formwork release agent will be used, as applicable.

I. Welding certificates.

J. Welding Procedures for all reinforcement welding.

K. Mill Test Reports: Submit steel producer's certificates of mill analysis for each heat or melt of reinforcing steel, including steel source, description, heat number, yield point, ultimate tensile strength, elongation percent, bend test and the chemical composition of each heat as determined

by ladle analysis, before delivery of steel to site. Where steel is required to be welded, mill reports shall be used to help verify the weldability of the steel.

L. Qualification Data: For Installer. Submit qualification of Concrete Foreman, showing 5 years experience with this type of concrete installation.

M. LEED Submittals: Refer to Section 018113.14 “Sustainable Design Requirements” for submittal requirements where LEED is being pursued for building.

N. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:

1. Lightweight aggregate (per ASTM C330).
2. Normal weight aggregate (per ASTM C33). Include evaluation of reactivity and the following:

    a. Abrasion Resistance: ASTM C131; Los Angeles Machine.

    b. Cleanness Value: Test Method NO. C 227; coarse aggregate only.

    c. Fineness: ASTM C117.

    d. Organic Impurities: ASTM C40.

    e. Potential Reactivity: ASTM C289.

    f. Sieve Analysis: ASTM C136.

    g. Soundness: ASTM C88.

    h. Absorption for lightweight aggregate: Maximum 15%.

O. Product Test Reports and Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials, per ASTM C150, ASTM C595, ASTM C618, ASTM C989, and/or ASTM C1240, as applicable.
2. Admixtures. Where more than one admixture is used, include certification that admixtures are compatible. Per ASTM C494 for each type used; include chloride ion content.
3. Form materials and form-release agents.
4. Steel reinforcement and accessories.
5. Welding Electrodes
6. Fiber reinforcement.
7. Waterstops.
8. Curing compounds.
9. Floor and slab treatments.
10. Non-shrink grout, per ASTM C1107.
11. Bonding agents.
12. Adhesives.
13. Vapor retarders.
14. Semirigid joint filler.
15. Joint-filler strips.
16. Post-installed concrete anchors.

17. Repair materials.

P. Submit a complete description of the system proposed for meeting the specified floor slab flatwork tolerances. Submit survey data from a minimum of two previous slab installations to demonstrate capability to satisfy specified tolerances.

1. Submit surface flatness and levelness measurements indicating compliance with the specified tolerances.

Q. Field quality-control test reports.

R. Submit an affidavit identifying cementitious material used, including manufacturer's lot number, date of shipment by manufacturer, date of receipt by the concrete supplier, place of storage and date of use. If such information is not available, a sample of cementitious material used on the Project shall be taken for each day's pour and shall be tested as directed by the Architect.

S. Transit-Mix Delivery Slips

1. Keep record at the Site showing time and place of each pour of concrete, together with transit mix delivery slip certifying contents of the pour per ASTM C94. Include the time water was added to dry mix.
2. Make the record available for inspection at the Site and to the Architect for his review upon request.
3. Upon completion of this portion of the Work, deliver the record and the delivery slips to the Architect.

T. Complete minutes of preinstallation conference within (5) business days.

1.5 QUALITY ASSURANCE

A. Standards: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
2. ACI 301, "Specification for Structural Concrete," Sections 1 through 5 and Section 7, "Lightweight Concrete."
3. ACI 318, “Building Code Requirements for Reinforced Concrete.”
4. ACI SP-66, “Detailing Manual”
5. American Welding Society (AWS) D1.4, “Structural Welding Code – Reinforcing Steel”
6. New York City Building Code.

B. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

C. Manufacturer Qualifications: 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."

D. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
3. Shop and field testing and inspection of steelwork shall be performed by an inspector currently certified as an AWS Certified Welding Inspector.

E. Testing Agency: Shall be selected and paid for by the Owner, unless otherwise specified; re-testing paid for by the Contractor.

F. Contractor's Quality Control Plan: Quality Control includes the functions performed by the Contractor to ensure that the material and workmanship of concrete construction meets the project specifications and applicable standards. The Contractor shall submit a Quality Control Plan that addresses all inspection issues, including testing and inspection per ACI. The verification testing and inspection carried out by the Testing Agency does not relieve the contractor of the responsibility for conducting their own quality control/inspection program to ensure the requirements of the Contract Documents have been met. The Contractor's Quality Control Plan will be reviewed by the Testing Agency.

G. Quality Control Inspector Qualifications: Along with Quality Control Plan, Contractor shall submit written qualifications for all inspectors to be assigned Quality Control functions for concrete work.

H. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.

I. Mechanical Bar Couplers shall have a current ICC-ES Evaluation Report that indicates compliance with requirements of these specifications.

J. Unidentifiable Reinforcing Steel: Tested by testing agency; paid for by Contractor:

1. Test reinforcing delivered to site which cannot be properly identified by heat number and mill mark for compliance with ASTM A615 as follows:

   a. No. 8 Bar and Smaller: One tensile test and one bend test of each size per 7-1/2 tons, or portion thereof.

   b. No. 9 Bar and Larger: One tensile test of each size per 10 tons, or portion thereof.

K. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel."

1. Welders whose work fails to pass inspection shall be requalified before performing further welding.

2. All welding shall be performed by operators who are qualified for the types of welds used. Each operator shall have been qualified within the preceding one year as prescribed by AWS. Welder qualification shall include passing the Charpy tests when specified for the electrode.
3. Require welders to retake the qualification test if, as determined by the Architect, there is a reasonable doubt as to the proficiency of the welder. If the welder does not requalify, they shall not perform any welding on the project.

L. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to test concrete mixtures. When mixes, are proportioned by trial batch method, engage a Laboratory conforming to ASTM E329 and under direction of a Professional Engineer licensed in New York.

M. Prefabrication and Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:

   a. Contractor's superintendent.

   b. Concrete subcontractor.

   c. Laboratory responsible for field quality control.

   d. Concrete pumping subcontractor

2. During meeting, review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semirigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.
3. The concrete contractor shall confirm that the proposed mix designs will enable him to properly place, pump, finish and achieve the required concrete quality specified.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement:

1. Deliver, store, and handle steel reinforcement to prevent bending and damage.
2. Deliver reinforcing to Site properly bundled and tagged. Use tags that indicate bar size, lengths and marks corresponding to markings shown on shop drawings. Segregate so as to maintain identification after bundles are broken.
3. Store reinforcement in a manner that will prevent excessive rusting or fouling with/ grease, oil, dirt, and other bond weakening materials.
4. Do not use damaged, reworked, or deteriorated material.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

C. Formwork: Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use.

D. Concrete Materials:

1. Protect cement from moisture and rotate stock to ensure fresh materials.
2. Protect aggregates as necessary to maintain saturated condition when batched.
3. Storage methods should comply with ACI 301 4.1.4.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
2. Products: Subject to compliance with requirements, provide one of the products specified.
3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FORM-FACING MATERIALS

A. Wood materials used for permanent formwork (e.g., dimensional lumber, plywood, other engineered wood products) shall be “FSC Certified” products which have been harvested in accordance with FSC international Principles and Criteria for well-managed forests developed by the Forest Stewardship Council (FSC).

B. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

1. Plywood, metal, or other approved panel materials.
2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

a. High-density overlay, Class 1 or better.

b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.

c. Structural 1, B-B or better; mill oiled and edge sealed.

d. B-B (Concrete Form), Class 1 or better; and edge sealed. Mill oil not allowed.

C. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

D. For exposed surfaces not otherwise specified use Special exterior Type Douglas Fir, Grade AB plywood, conforming to NBS PS-1, minimum 3/4 in. thick and constructed so that finished concrete will be straight, smooth, dense, free from honeycombs, bulges, or depressions. Keep joints between plywood sections to a minimum and make tight and strongly backed so that adjoining edges remain flush and true.

E. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation. For areas exposed to view, use new forms or specially selected forms.

F. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.

G. Foam Filler or High Density Styrofoam Fill: Expanded polystyrene foam, ASTM C578, Type IX, 1.9 pounds per cubic foot density.

H. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

I. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

J. Form Gaskets (for sealing form panel joints) Gaskets shall be closed cell, completely skinned, foam rubber or neoprene, with pressure sensitive paperbacked adhesive on surfaces to be bonded to forms. Gaskets shall be of sufficient thickness, widths and compressibility for specific use.

K. Form Sealer (Wood Forms): All form sealers shall be of a type which will not harmfully affect the appearance and/or utility of the concrete surface or the application of sealers, paint, vinyl fabric or any other finishes. In addition, form sealer shall prevent the development of bond or adhesion to concrete.

L. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

M. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that will leave no corrodible metal closer than 1-1/2 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 and permit neat and solid patching at every hole.
3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

N. Expansion Joint Filler:

1. Fiber Type: Preformed asphalt impregnated fiber, ASTM D1751, 1/2 inch thick unless otherwise noted.
2. Cork Type: Preformed cork expansion joint, ASTM D1752. Type II, 1/2 inch thick unless otherwise noted.

O. Expansion Joint Sealant: ASTM C920, Type M, Class 2 5; two part polyurethane traffic grade sealant, gray color.

1. Horizontal Joints: Pourable, Grade P, Use T.
2. Vertical Joints: Nonsag, Grade NS, Use NT.

P. Foundation Formwork – Leave in Place: Ribbed mesh fabricated from galvanized sheet steel; stay-form, or equal.

2.3 STEEL REINFORCEMENT

A. Reinforcing Bars:

1. ASTM A615, Grade 60, deformed, unless noted otherwise.
2. ASTM A706, deformed, where designated on drawings.

B. Headed Bar Reinforcement: ASTM A970.

C. Steel Bar Mats: ASTM A 184/A 184M, fabricated from ASTM A615, Grade 60, deformed bars, assembled with clips.

D. Tie Wire: American Wire 16 gauge or heavier black annealed wire.

E. Plain-Steel Wire: ASTM A82, as drawn.

F. Deformed-Steel Wire: ASTM A496.

G. Plain-Steel Welded Wire Reinforcement: ASTM A1064, plain, fabricated from as-drawn steel wire into flat sheets.

H. Deformed-Steel Welded Wire Reinforcement: ASTM A1064, flat sheet.

2.4 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A615, Grade 60, plain-steel bars, cut bars true to length with ends square and free of burrs.

B. Epoxy-Coated Joint Dowel Bars: ASTM A615, Grade 60, plain-steel bars, ASTM A775epoxy coated.

C. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A775.

D. Zinc Repair Material: ASTM A780, zinc-based solder, paint containing zinc dust, or sprayed zinc.

E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel

wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

1. For concrete surfaces exposed to view or where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports, unless noted otherwise.
2. Where supports are placed against ground or atop vapor barrier use precast concrete blocks not less than 3 inches square with two 16 gauge embedded wires.
3. At Architectural Concrete and surfaces exposed to weather; CRSI Class 1 plastic protected.

F. Mechanical Bar Couplers: Provide coupler capable of achieving Type 1- splice, unless otherwise noted on Drawings.

1. Type 1: ICC-ES approved; capable of developing 125% of specified minimum yield strength of bar in tension or compression.
2. Type 2: ICC-ES approved; capable of developing the lesser of 95% of the ultimate tensile strength or 160% of the specified minimum yield strength of the bar in tension or compression.

G. Welding Electrodes: As required in AWS D1.4. As a minimum, use E90XX electrodes.

H. Deformed Bar Anchors: Nelson, flux filled deformed bar anchors, type D2L, as manufactured by Nelson Stud Welding Division of TRW or approved equal.

2.5 REINFORCEMENT FABRICATION

A. Fabricate reinforcing in accordance with ACI 301, 315 or CRSI "Manual of Standard Practice."

B. Bending:

1. Do not bend or kink reinforcing except as shown on the Drawings.
2. Minimum bend diameters and hook extensions as shown on the drawings or per ACI.
3. In case of fabrication errors do not rebend or straighten reinforcement in a manner that will injure or weaken the material.
4. Reinforcing bars are to be bent cold, do not preheat, unless approved by Architect.
5. Do not rebend reinforcement that has previously been bent within 6 inches of new bend except as allowed in section 3.3.2.8 of ACI 301.

C. Unacceptable Materials: Reinforcement with any of the following defects shall not be permitted in the Work and will be replaced without cost:

1. Bar lengths, depths and bends exceeding specified fabrication tolerances.
2. Bend or kinks not shown on the Drawings or final shop drawings.
3. Bars with reduced cross-section due to rusting or other cause.
4. Bars with dirt, mud, grease or form release agent.

2.6 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C150, Type II, unless noted otherwise.

    a. Portland Cement: ASTM C150, Type I/II.

2. Supplement Portland Cement with the following Supplementary Cementitious Materials (SCM):

    a. Fly Ash: ASTM C618, Class F.

    b. Slag Cement: ASTM C989, Grade 100 or 120.

    c. Silica Fume: ASTM C1240.

    d. Metakaolin: ASTM C618.

    e. The SCM producer shall have a minimum of 5 years experience in the production of acceptable SCM and shall practice an effective quality control program to guard against contamination of the SCM.

3. Cementitious material used shall have at least 2 years of use with proposed aggregates without detrimental reaction.
4. Alkali content shall not exceed 0.6% when tested in accordance with ASTM C114.
5. The temperature of cement delivered to the plant shall not exceed 150 degrees F.

B. Silica Fume: ASTM C1240, amorphous silica.

C. Normal-Weight Aggregates: ASTM C33, coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.

1. Coarse Aggregate:

    a. Aggregate shall contain no thin or elongated pieces. Any piece having a major dimension more than 2-1/2 times the average thickness shall be considered thin or elongated.

    b. If shrinkage controlled concrete, Coarse Aggregate shall be crushed limestone, granite, or accepted equal.

    c. Alkali Silica Reactivity: Aggregate shall be considered non-reactive with documented satisfactory service record for a minimum of ten year period used in concrete with similar cementitious materials. In the absence of service record the aggregate shall be tested and will be considered non-reactive if it passes ASTM C1260 or ASTM C1293 per requirements of the Engineer of Record.

    d. The maximum size used in a particular location shall be consistent with the form and dimensions of the section being placed, with the location and spacing of the reinforcing steel and with the method of vibration. The aggregate sizes shall be such as will produce dense, uniform concrete, free of rock pockets, honeycombs, or other irregularities.

e. Combined aggregate gradation for slabs and other designated concrete shall be 8% to 18% for large top size aggregates (1-1/2-inch) or 8% - 22% for smaller top size aggregates (1-inch or 3/4-inch) retained on each sieve below the top size and above the No. 100.

2. Fine Aggregate: Uniformly graded, clean sand, free from excessive fines, organic materials or other deleterious materials. Free of materials with deleterious reactivity to alkali in cement.
3. Combined Aggregate Gradation: Combined aggregate gradation for slabs and other designated concrete shall be 8% - 18% for large size aggregates (1 ½ in.) or 8% - 22% for smaller top size aggregates (1 in. or ¾ in.) retained on each sieve below the top size and above the No. 100.

D. Lightweight Aggregate: ASTM C330, 3/4-inch nominal maximum aggregate size.

1. Lightweight cellular and granular inorganic materials, free from oil, organic matter, or other deleterious substances.
2. Uniformly graded from 1/4-inch to maximum size. The combined grading shall be such that the percentage of weight of the combined aggregates shall fall within the limits established by ASTM C330.
3. Dry weight of lightweight concrete shall not be greater than 115 pcf.
4. Lightweight Aggregates Rotary Kiln Produced: Expanded shale slate, clay or slag aggregate, the maximum size used in a particular location shall be consistent with the form and dimensions of the section being placed, with the location and spacing of the reinforcing steel and with the method of vibration. The aggregate sizes shall be such as will produce dense, uniform concrete, free of honeycombs, or other irregularities.

E. Water: ASTM C1602 clean, free from deleterious matter. Non-potable water is acceptable if meets the chemical content limits of ASTM C1602

2.7 ADMIXTURES

A. General: Admixtures may only be used if accepted by the Owner's Representative in accordance with ACI 318/318R 3.6 if they comply with requirements of ASTM C494. Where more than one is used, admixtures shall be compatible. Use of admixtures shall be consistent throughout Work.

1. Where specified herein do not use other admixtures without the written acceptance of the Architect.
2. Prohibited Admixtures: Admixtures containing intentionally-added chlorides are not permitted. Do not use admixtures that will negatively impact the visual finish of concrete exposed to view.

B. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other admixtures .

1. Available Products:

a. Grace Construction Materials; Darex AEA or Daravair

b. MasterAir AE 90 (formerly MB-AE 90), MasterAir AE 100 (formerly Micro Air) or MasterAir VR 10 (formerly MB VR Standard) by BASF Corporation or approved equal.

c. Euclid Chemical Company (The); Air Mix

C. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. .

1. Water-Reducing (Plasticizing) Admixture: ASTM C494, Type A.
2. Retarding Admixture: ASTM C494, Type B.
3. Accelerating Admixture or Water-Reducing and Accelerating Admixture: ASTM C494, Type C or Type E
4. Water-Reducing and Retarding Admixture: ASTM C494, Type D.
5. High-Range, Water-Reducing (Superplasticizers) Admixture: ASTM C494, Type F.
6. High-Range, Water-Reducing and Retarding Admixture: ASTM C494, Type G.
7. Plasticizing and Retarding Admixture: ASTM C1017, Type II.
8. Workability-Retaining Admixture: ASTM C494, Type S.
9. Corrosion-inhibiting admixture: Shall be a nominal 30 percent solution of calcium nitrite or an amine/ester-based organic corrosion-inhibiting admixture.
10. Shrinkage-Reducing Admixture: ASTM C494, Type S.
11. Alkali-Silica Reaction-Inhibiting Admixture: ASTM C494, Type S. Shall contain a nominal lithium nitrate content of 30 percent.
12. Viscosity-Modifying Admixture: ASTM C494, Type S.

2.8 WATERSTOPS

A. Flexible Rubber Waterstops: CE CRD-C 513, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

1. Available Manufacturers:

a. Greenstreak.

b. Progress Unlimited, Inc.

c. Williams Products, Inc.

d. Fosroc

e. Adeka

2. Profile: Flat, dumbbell without center bulb.
3. Dimensions: 6 inches by 3/8 inch thick; nontapered.

B. Flexible PVC Waterstops: CE CRD-C 572, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

1. Available Manufacturers:

a. Bometals, Inc.

b. Greenstreak.

c. Meadows, W. R., Inc.

d. Murphy, Paul Plastics Co.

e. Progress Unlimited, Inc.

f. Tamms Industries, Inc.

g. Vinylex Corp.

2. Profile: Flat, dumbbell without center bulb.
3. Dimensions: 6 inches by 3/8 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. Available Products:

a. Colloid Environmental Technologies Company; Volclay Waterstop-RX.

b. Concrete Sealants Inc.; Conseal CS-231.

c. Greenstreak; Swellstop.

d. Henry Company, Sealants Division; Hydro-Flex.

e. JP Specialties, Inc.; Earthshield Type 20.

f. Progress Unlimited, Inc.; Superstop.

g. TCMiraDRI; Mirastop.

D. Self-Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free hydrophilic polymer modified chloroprene rubber, for adhesive bonding to concrete, 3/8 by 3/4 inch.

1. Available Products:

a. Deneef Construction Chemicals; Swellseal.

b. Greenstreak; Hydrotite.

c. Mitsubishi International Corporation; Adeka Ultra Seal.

d. Progress Unlimited, Inc.; Superstop.

2.9 VAPOR RETARDERS

A. Plastic Vapor Retarder: ASTM E 1745, Class A, not less than 10 mils thickness. Include manufacturer's recommended adhesive or pressure-sensitive tape. Plastic Vapor Retarder shall have a water-vapor transmission rate no greater than .012 perms (grain/h xft2 in x Hg) when tested in accordance with ASTM E96.

1. Available Products:

a. Alumiseal Corporation; Zero Perm Vapor Barrier.

b. Fortifiber Corporation; Moistop Ultra A.

c. Raven Industries Inc.; Vapor Block .

d. Reef Industries, Inc.; Griffolyn.

e. W.R. Meadows, Inc.; Plasmatic Core.

B. Plastic Vapor Retarder: ASTM E 1745, Class B. Include manufacturer's recommended adhesive or pressure-sensitive tape. Plastic Vapor Retarder shall have a water-vapor transmission rate no greater than .012 perms (grain/h xft2 in x Hg) when tested in accordance with ASTM E96.

1. Available Products:

a. Fortifiber Corporation; Moistop Ultra.

b. Raven Industries Inc.; Vapor Block 10.

c. Stego Industries, LLC; Stego Wrap, 15 mils.

C. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D 448, Size 57, with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

D. Fine-Graded Granular Material: Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D 448, 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.

2.10 FLOOR AND SLAB TREATMENTS

A. Metallic Dry Shake Floor Hardener: Unpigmented, factory-packaged, dry combination of portland cement, graded emery aggregate and plasticizing admixture with emery aggregate consisting of no less than 60 percent of total aggregate content. Available products: EucoPlate HD, MasterTop 200 (Formerly Masterplate 200) by BASF Corporation, or approved equal.

B. Non-Oxidizing Metallic Floor Hardener: The specified non-oxidizing metallic floor hardener shall be formulated, processed and package under stringent quality control at the manufacturer's owned and controlled factory. The hardener shall be a mixture of specially processed non-rusting aggregate, selected portland cement and necessary plasticizing agents. Provide one of the following: Diamond Plate by The Euclid Chemical Company, MasterTop 210 COR (Formerly Lumiplate) by BASF Corporation, or approved equal..

C. Mineral Dry-Shake Floor Hardener: The specified mineral aggregate hardener shall be formulated, processed and packaged under stringent quality control at the manufacturer's owned and controlled factory. The hardener shall be a factory blended mixture of specially processed graded mineral aggregate, selected portland cement and necessary plasticizing agents. Available Products: Surflex by The Euclid Chemical Company, MasterTop 100 (Formerly Mastercron) by BASF Corporation, or approved equal.

D. Liquid Sealer and Densifier: High performance, deeply penetrating concrete densifier; odorless, colorless, non-yellowing siliconate based solution designed to harden, dustproof and protect concrete floors subjected to heavy vehicular traffic and to resist black rubber tire marks on concrete surfaces. The compound must contain a minimum solids content of 20% of which 50% is siliconate. Available products: Euco Diamond Hard by The Euclid Chemical Company, Seal Hard by L & M Construction, MasterKure HD 210 WB (Formerly Kure-N-Harden) by BASF Corporation, or approved equal.

E. Sealer for Colored Concrete: Clear, penetrating, water-based, low-luster sealer recommended by the pigment manufacturer. It shall be compatible with colored concrete components and will not adversely affect concrete color or slip resistance.

2.11 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete. Available products:

1. MasterKure ER 50 (formerly Confilm) by BASF Corporation or approved equal.

B. Absorptive Cover: AASHTO M182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C171, polyethylene film, fiber reinforced asphaltic vapor barrier building paper, or white burlap-polyethylene sheet.

1. Provide in a thickness of 42 mils; standard weight of 53 lbs./1000 ft2; tensile strength (machine direction) of 36 lbs./in.; and puncture resistance of 70 lbs.

D. Water: ASTM C1602 clean, free from deleterious matter. Non-potable water is acceptable if meets the chemical content limits of ASTM C1602.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1-D, dissipating. Sodium silicate compounds are prohibited.

F. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering. Sodium silicate compounds are prohibited. Available products: Diamond Clear VOX or Super Diamond Clear VOX by The Euclid Chemical Company, or approved equal.

G. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, 18 to 25 percent solids, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering. Sodium silicate compounds are prohibited.

H. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C1315, Type 1, Class A. Sodium silicate compounds are prohibited.

I. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C1315, Type 1, Class A. Sodium silicate compounds are prohibited.

J. Curing and Sealing Compound: (VOC Compliant, 350 g/l): Liquid type membrane forming curing compound, clear styrene acrylate type, complying with ASTM C1315, Type I, Class A, 25% solids content minimum. Moisture loss shall be not more than 0.40 Kg/m2 when applied at 300 sq.ft./gal. Manufacturer's certification is required. Available products: Super Diamond Clear VOX, or Super Aquacure VOX by The Euclid Chemical Company, MasterKure CC 1315 (Formerly Kure 1315) by BASF Corporation, or approved equal.

2.12 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber.

B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 or aromatic polyurea with a Type A shore durometer hardness range of 90 to 95 per ASTM D2240.

C. Bonding Agent: ASTM C1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

D. Epoxy Bonding Adhesive: ASTM C881, 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. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete. Available products: Duralcrete Series by The Euclid Chemical Company, Sikadur Hi-Mod Series by Sika, MasterEmaco ADH Series (Formerly Concresive) by BASF Corporation, or approved equal.

E. Post-Installed Concrete Anchors:

1. Expansion Anchors: Kwik Bolt III or TZ by Hilti Inc, Trubolt Wedge by ITW Ramset/Red Head, Power-Stud by Powers-Rawl, or approved equal.
2. Epoxy Dowels / Epoxy Anchors: HIT HY 200 by Hilti, Inc., CIA-Gel 7000 by Covert Operations, SET by Simpson Strong Tie, Power-Fast by Powers-Rawl, or approved equal.
3. Grouted Dowels / Grouted Anchors: High strength non-shrink grout to anchor reinforcing steel or threaded rods in concrete shall be Hi-Flow Grout by The Euclid Chemical Company or MasterFlow 928 grout as manufactured by BASF Corporation, Sika Grout 212 as manufactured by Sika Corporation, or approved equal.

F. Reglets: Fabricate reglets of not less than 26 gauge, galvanized steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

G. Dovetail Anchor Slots: Hot-dip galvanized steel sheet, not less than 22 gauge, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.13 MORTARS AND GROUTS

A. Bonding Grout: Approximately 1 part Portland cement to 1 part fine sand passing a no 30 sieve and a 50/50 mixture of approved bonding admixture and water, mixed to a consistency of thick paint and not exceeding the w/cm of the concrete to be bonded.

B. Patching Mortar for exposed concrete shall be made of the same material and of approximately the same proportions as used for concrete, except that coarse aggregate shall be omitted and mortar shall consist of not more than 1 part Portland cement to 2-1/2 parts damp loose sand by volume.

1. Combine white and gray Portland cement as necessary to match color specified by Architect. Use no more mixing water than necessary for handling and placing.
2. Mix patching mortar in advance and allow to stand with frequent mixing with trowel without adding water until it has reached the stiffest consistency that will permit placing.

C. High Flow Grout:

1. Where high fluidity and/or increased placing time is required, use high flow grout.
2. ASTM C1107, “Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-Shrink)”.
3. When placed at a fluid consistency there shall be at least 95% bearing under an 18 inches x 36 inches base plate.
4. “Hi-Flow Grout” manufactured by The Euclid Chemical Company, “MasterFlow 928” manufactured by BASF Construction Products, or approved equal.

D. Epoxy grout for anchor reinforcing steel or threaded rods in concrete shall be MasterEmaco ADH 1490 (Formerly Concresive 1490) as manufactured by BASF Construction Products, or Sikadur 32 Hi-Mod as manufactured by Sika Corporation, or Epoxy 452 or E3G by Euclid Chemical Company, or approved equal.

E. Cementitious grout for anchor reinforcing steel or threaded rods in concrete shall be MasterFlow 928 grout as manufactured by BASF Corporation, Sika Grout 212 as manufactured by Sika Corporation, Hi-Flow grout by Euclid Chemical Company, or approved equal.

F. Drypack Mortar for Form Holes at Non-Architectural Grade Surfaces: Composed of 1 part Portland cement and 2 parts of fine aggregate and water. Match color of adjacent surfaces.

2.14 REPAIR MATERIALS

A. High Strength Flowing Repair Mortar: For forming and pouring structural members, or large horizontal repairs, provide the flowable one-part, high strength microsilica modified repair mortar with 3/8” aggregate. The product shall achieve 9000 psi @ 28-days at a 9-inch slump. Available products: MasterEmaco S 466 CI (Formerly Emaco S66 CI) by BASF Corporation, Eucocrete by The Euclid Chemical Company, or approved equal.

B. Patching Mortar:

1. Horizontal repairs, ASTM C928. Available Products:

a. Euclid Chemical Co.: Euco Thin Top Supreme, Concrete Top Supreme

b. Sika Chemical Corp.: Sikatop 121 or 122

c. BASF Corporation: MasterEmaco T 310 CI (Formerly Emaco R310 CI)

2. Vertical or Overhead repairs, ASTM C928. Use as recommended by manufacturer for overhead use. Available Products:

a. Euclid Chemical Co.: Verticoat, Verticoat Supreme or Speed Crete Red Line

b. Sika Chemical Corp.: Sikatop 123

c. BASF Corporation: MasterEmaco N 350 CI (Formerly Emaco R350 CI) or MasterEmaco N 425 (Formerly Gel Patch)

C. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C219.
2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
4. Compressive Strength: Not less than 4000 psi at 28 days when tested according to ASTM C109.
5. Bond Strength: Not less than 1000 psi at 28 days when tested according to ASTM C1042.
6. Available Products:

a. Euclid Chemical Co.: Super Flo-Top

b. BASF Corporation: MasterTop 110 SL (Formerly Mastertop 110 Plus)

D. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C219.
2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than strength of substrate at 28 days when tested according to ASTM C109.
5. Available Products:

a. Euclid Chemical Co.; Thin Top Supreme or Tammspatch II

b. BASF Corporation; MasterEmaco N 300 CI (Formerly Emaco R300 CI)

6. Product shall exhibit the following properties: Chaplin Abrasion Test – 0.0079-inches maximum at 28 days.

2.15 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301. The mixes shall be submitted on mix design submittal form at the end of the specification.

1. Procurement of concrete mix design is responsibility of Contractor.
2. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
3. At the discretion of the Engineer of Record a manufacturer's laboratory may also be approved to perform trial batching. The Manufacturer's lab must be run under the direct supervision of a Professional Engineer and technicians performing the tests must be Both ACI Concrete Field Testing Technician Grade I and Laboratory Testing Technician grade I certified. The facilities must be adequate to properly perform the testing required.

B. Limit water-soluble, chloride-ion content in hardened concrete to tthe limits specified in ACI 318.

C. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing or high-range water-reducing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use accelerating or water-reducing and accelerating admixture in concrete, as required, for cold weather placement or when acceleration of setting time is required.
4. Use high range water-reducing in all fiber concrete pumped concrete, self-consolidating concrete and any concrete with water/cementitious materials ratio below 0.50.

2.16 CONCRETE MIXTURES

A. Definition of Mix Properties:

1. Concrete strength (f'c) is the minimum compressive strength at 28 days, tested in accordance with ASTM C39.
2. Aggregate size is the largest of the coarse aggregate.
3. Slump shall be measured at the point of delivery in accordance with ASTM C143. Slump tolerance shall meet the requirements of ACI 117. Slump can be increased with use of a high-range water-reducer to improve workability of mix. After addition of high-range water-reducer, slump shall not exceed 9" at point of delivery.
4. Air content is by volume and may be plus or minus 1.5 percent at point of delivery.
5. Water/cementitous materials ratio is specified by weight.
6. Drying shrinkage limit is percentage change in length after 28 days of drying when tested as per ASTM C157 with 4 inches x 4 inches x 11 inches specimen moist cured 7 days prior to drying.

B. Foundations: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength (f'c): 4000 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.45.
3. Maximum Aggregate Size: 1 inch.
4. Slump Limit: 4 inch maximum slump with water reducing admixture or 8 inch maximum slump with high-range water-reducing admixture, plus or minus 1 inch.
5. Air Content: 4.5 plus or minus 1.5 percent percent.

C. Walls, Columns, Beams, Curbs: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength (f'c): 4000 psi at 28 days.

2. Maximum Water-Cementitious Materials Ratio: 0.45.
3. Maximum Aggregate Size: 3/4 inch.
4. Slump Limit: 4 inch maximum slump with water reducing admixture or 8 inch maximum slump with high-range water-reducing admixture, plus or minus 1 inch.

D. Water Tank Walls and Slabs: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength (f'c): 4000 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.45.
3. Maximum Aggregate Size: 3/4 inch.
4. Slump Limit: 4 inch maximum slump with water reducing admixture or 8 inch maximum slump with high-range water-reducing admixture, plus or minus 1 inch.

E. Interior Slab-on-Grade with thickness greater than 6 inches: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength (f'c): 4500 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.45.
3. Maximum Aggregate Size: 1 inch.
4. Slump Limit: 4 inch maximum slump with water reducing admixture or 8 inch maximum slump with high-range water-reducing admixture, plus or minus 1 inch.
5. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.

F. Interior Slab-on-Grade with thickness less than or equal to 6 inches: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength (f'c): 4000 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.45.
3. Maximum Aggregate Size: 3/4 inch.
4. Slump Limit: 4 inch maximum slump with water reducing admixture or 8 inch maximum slump with high-range water-reducing admixture, plus or minus 1 inch.
5. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.

G. Exterior Slab-on-Grade: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength (f'c): 4500 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.45.
3. Maximum Aggregate Size: 3/4 inch.
4. Slump Limit: 4 inch maximum slump with water reducing admixture or 8 inch maximum slump with high-range water-reducing admixture, plus or minus 1 inch.
5. Air Content: 6 plus or minus 1.5 percent percent. Do not allow air content of trowel-finished floors to exceed 3 percent.
6. Supplementary Cementitious Materials to be limited as required for Concrete Assigned to Exposure Class F3 as defined by ACI 318.
7. See Division 03 "Exposed Aggregate Concrete Pavement" for additional requirements for Architectural exterior slabs-on-grade.

H. Topping Slabs: see Division 03 "Architectural Topping Slabs"

I. Fill Below Foundations: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength (f'c): 1000 psi at 28 days.

2.17 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.18 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.

1. The batching plant shall be equipped with an electric metering device capable of determining moisture content of sand.
2. Begin the mixing operation within thirty minutes after the cement has been intermingled with the aggregates.
3. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes. Alternatively a retarding admixture may be used where results from testing can be provided for approval by the Engineer of Record.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

C. Lightweight Concrete: Mix lightweight concrete in accordance with the directions of the approved lightweight aggregate manufacturer.

PART 3 EXECUTION

3.1 PRECONSTRUCTION MEETING

A. At least three weeks prior to commencement of concrete work, meet at the Project site to review the proposed mix designs, methods and sequence of concrete construction, standard of workmanship, material selection, testing and quality control requirements, placement procedures, off-site batching requirements, coordination of the work with other trades and other pertinent topics related to the Work. The meeting shall include the following:

1. Owner's Representative
2. Architect/Engineer
3. Construction Manager/General Contractor
4. Concrete Subcontractor
5. Owner's Testing Laboratory
6. Ready Mix Concrete Supplier
7. Formwork Manufacturer/Supplier

8. Lightweight Aggregate Supplier
9. Concrete pumping subcontractor
10. Any other subcontractor and/or material supplier including plumbing, waterproofing and electrical supplier or manufacturer required

B. The minutes shall include a statement by the concrete contractor indicating that the proposed mix design and placing techniques shall produce the concrete quality required by these specifications.

3.2 PREPARATION

A. Prior to Work specified in this Section, carefully inspect the installed Work of other trades and verify that such Work is complete to the point where this installation may properly commence.

B. Verify that forms may be constructed in accordance with all applicable codes and regulations, the referenced standards, and the design documents.

1. Ensure Excavations are sufficient to permit placement, inspection, and removal of forms.
2. Verify reinforcing steel has been inspected prior to concealing with formwork.
3. Verify geotechnical engineer has approved all foundation excavations.

C. The Contractor shall verify all dimensions prior to starting construction.

D. Coordinate:

1. Obtain necessary information for coordination of formwork with items to be embedded in concrete.
2. Coordinate size and location of openings in concrete. Obtain Architects approval for openings not shown on Structural Drawings.

E. Discrepancies:

1. Notify the Architect of any discrepancies or inconsistencies.
2. Do not proceed with installation in areas of discrepancy until such discrepancies have been fully resolved.

3.3 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads and such that formwork can withstand excessive deflection when filled with wet concrete.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, camber and position indicated, within tolerance limits of ACI 117. Make proper provision for all openings, offsets, recesses, anchorage, blocking, and other features of the Work as shown or required. Provide openings as required for vibrators and concrete placing.

C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:

1. Class A, 1/8 inch for smooth-formed finished surfaces.
2. Class B, 1/4 inch for rough-formed finished surfaces.

D. Construct forms tight enough to prevent loss of concrete mortar. Tape all joints at forms for sandblasted finished concrete, including joints between plywood and trim strips.

E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

1. Install keyways, reglets, recesses, and the like, for easy removal.
2. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

H. Chamfer exterior corners and edges of permanently exposed concrete.

I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement. 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.

3.4 EARTH FORMS

A. Earth Forms: Unless otherwise indicated or required by the Construction documents, concrete for foundations that will remain in permanent contact with the soil may be placed directly against vertical excavated surfaces provided the material will stand without caving and suitable provisions are taken to prevent raveling of top edges or sloughing of loose material from walls of excavation. Sides of excavation shall be made with a neat cut and the width made as detailed on Drawings.

1. Where sides are unstable or excavations are not accurately cut tolerances of ACI 301, construct formwork to the extent required, at no additional cost to Owner.
2. Hand trim sides and bottom of earth forms; remove loose dirt prior to placing concrete.
3. Form footings to minimum extent shown on Drawings.

3.5 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded. Ensure that embedded items

are placed and held, during placing of concrete, to tolerances consistent with other items that will be attached to them.

1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
3. Install dovetail anchor slots in concrete structures as indicated.
4. Install concrete accessories in accordance with manufacturer's recommendations: straight, level, and plumb.

B. Provide pipe sleeves when pipes pass through concrete. Fill voids in sleeves, inserts and anchor slots with readily removable material to prevent entry of concrete into voids.

C. No conduit shall be cast in concrete unless specifically indicated on the Structural Drawings.

D. Coring of concrete after placement is not permitted without prior approval by the Engineer of Record.

3.6 REMOVING AND REUSING FORMS

A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.

1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 70 percent of its specified design compressive strength, f'c.
2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
3. When forms are removed in less than 7 days, curing shall be continued as follows:

    a. Loosen form ties and run water down inside of form to keep concrete wet.

    b. Immediately following form removal, thoroughly wet surface.

    c. Continue curing as specified elsewhere in this specification.

B. Remove forms carefully to avoid damaging corners and edges of exposed concrete. Prying against the face of concrete shall not be allowed.

C. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

D. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

E. Re-use of forms shall in no way delay or change the schedule for placement of concrete from the schedule obtained if all of the forms were new.

F. All forms below ground surface, along with all shores and braces, shall be removed before backfilling.

3.7 SHORES AND RESHORES

A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.

1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.

B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.

C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.8 VAPOR RETARDERS

A. Plastic Vapor Retarders: Place, protect, and repair vapor retarders according to ASTM E 1643 and manufacturer's written instructions.

1. Lap joints 6 inches and seal with manufacturer's recommended tape.

B. The vapor barrier installation must be approved prior to the concrete placement.

3.9 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

1. Wherever embedded items interfere with placing of reinforcement notify the Architect and obtain approval before placing any concrete. Do not bend or field cut bars around openings or sleeves.
2. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete. Where there is a potential of rust staining adjacent finish surfaces, take necessary steps to prevent staining.

C. Accurately position, support, and secure reinforcement against displacement, particularly under the weight of workmen and the placement of concrete. Use bar supports in sufficient number, size and location to prevent vertical displacement of the reinforcement and gouging of the formwork. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

1. Do not exceed the tolerances specified in ACI 117.
2. Reinforcement shall be held in place by means of supports adequate to prevent displacement and to maintain reinforcement at proper distance from form face. The use of wood supports and spacers inside the forms is not permitted.

3. Dowels shall be tied securely in place before concrete is deposited. In the event there are no bars in position to which dowel may be tied, No 3 bars (minimum) shall be added to provide proper support and anchorage.
4. Do not place reinforcement in floor slabs or beams until concrete has been placed in columns and walls, except where bars extend down into columns or walls.
5. Use templates for placement of column dowels.
6. Where Drawings do not show the spacing of the reinforcing, the minimum clear spacing shall conform to ACI 318 Section 7.6.
7. Reinforcing partially embedded in concrete shall not be field bent except as shown on the Drawings or accepted by the Architect.
8. Wherever conduits, piping, inserts, sleeves, etc., interfere with placing of reinforcing steel, obtain acceptance of method of procedure before any concrete is placed. Bending of bars around openings or sleeves not permitted.
9. Weld reinforcing bars according to AWS D1.4, only where indicated on drawings. Welding is not permitted on bars where the carbon equivalent is unknown. Do not weld within 2 bar diameters of where bars have been bent cold. Welding material, wire cuttings and tramp metal shall be thoroughly cleaned from forms for exposed concrete before any concrete is placed.

D. Splicing: Make splices only at those locations shown on the Drawings or as accepted by the Architect. Splice locations not shown on the Drawings shall be approved in shop drawings before fabrication. Stagger splices in adjacent bars wherever possible.

E. Reinforcing shall be rigidly and securely tied with steel tie wire. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

F. If allowed, field bending or straightening shall be in accordance with section 3.3.2.8 of ACI 301.

G. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing plus 2 inches or 6 inches, whichever is greater. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

H. Install deformed bar anchors in accordance with the manufacturer's recommendations.

I. Install mechanical splices and reinforcing couplers in accordance with manufacturers' recommendations.

3.10 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Existing Concrete to New Concrete Joints

1. Chip keys and roughen existing concrete surfaces where new concrete abuts. Roughen surface by bushhammering, chipping or sandblasting to remove surface mortar and expose clean aggregate.
2. Drill and install dowels using epoxy grout in accordance with manufacturer's printed recommendations.
3. Prime surface with 10-mil layer of epoxy adhesive using a stiff brush. Place concrete while the epoxy adhesive is still tacky. Re-prime if necessary.

C. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
2. In walls, do not space construction joints more than 60 feet apart in horizontal direction, maximum 20 feet apart in vertical direction unless otherwise shown. In framed slabs and beams, and on metal deck slabs, do not space construction joints more than 120 feet apart. In slabs on grade, do not space construction joints more than maximum 60 feet in any direction. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints except as otherwise shown.
3. Form keyed joints at indicated locations. Embed keys at least 1-1/2 inches into concrete.
4. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
6. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
7. Roughen surface at all construction joints where key is not used and under baseplates. Roughen concrete surface while concrete is still green where possible. Do not leave laitance, loosened particles of aggregate or damaged concrete at surface. Forms and reinforcing shall be cleaned of drippings. Dampen contact surfaces of construction joints, leaving them free of standing water, before placing fresh concrete.
8. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

D. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness, unless otherwise indicated on the drawings, as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

E. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Division 07 Section "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

F. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.11 WATERSTOPS

A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions. Comply with ACI 301.

3.12 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed. Ensure that all foreign material has been removed from surfaces, including reinforcement and embedded items, against which concrete will be placed.

B. The addition of water to the mix after leaving the plant is not permitted unless approved by Architect.

C. Method: Convey concrete as rapidly and directly as practicable to preserve quality and to prevent segregation.

1. Do not deposit concrete that has initially set. Retempering of concrete, which has partially set, is not permitted.
2. Maximum time for discharge of concrete shall be per ASTM C94.

D. Sequence: Pour all walls and columns full height to designated construction joints. Pour all beams, and horizontal structures to designated construction joints. Construction joints to be made in walls only where indicated on the Drawings.

E. Placement: Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete. Deposit concrete to avoid segregation.

1. When placing is once started, carry it on as a continuous operation until placement of the panel or section is complete. Construction joints to be made only where indicated on the Drawings or on approved shop drawings. Prevent the formation of cold joints at other locations.
2. Deposit concrete in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. Deposit concrete in a manner to avoid inclined construction joints.
3. Particular care shall be used when starting a concrete pour to maintain the continuity of appearance. Use all means necessary to avoid blemishes, imperfections, or changes in the finish.
4. Maintain reinforcement in position on chairs during concrete placement.

F. Consolidation: Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.

1. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301. Use and type of vibrator shall conform to ACI 309, Guide for Consolidation of Concrete.
2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. Place vibrating element directly in concrete and not attached to either inside or outside of forms or to reinforcing steel.
3. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate. Do not over-vibrate concrete.

G. Initial Finishing:

1. Screed slab surfaces with a straightedge and strike off to correct elevations.
2. Where floor drains or floor slopes are indicated, slope slabs uniformly to provide even fall for drainage.
3. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

H. Fill Over Steel Deck:

1. At floor slabs, increase fill thickness as required to compensate for deflection of beams and deck at no additional cost to Owner. Obtain specified fill thickness at high points of the deck. Finish floor to specified tolerances for floor flatness and levelness, including at suspended fill on steel deck floors
2. At roof, maintain specified thickness of concrete uniformly over deck. Slab need not conform to flatness and levelness tolerances

I. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When concrete is expected to be placed at air temperatures of less than 40 deg F, contractor shall review with Architect all special procedures that will be used including mix design modifications and methods of protection. This review shall occur prior to the expected extreme temperatures.
2. Provide sufficient protection material and equipment on the Project site in advance of the time when the mean daily temperatures are expected to drop below 40 degrees F.
3. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301. In addition, take precautions including, but not limited to:

    a. Use non-chloride, non-corrosive accelerating admixture in accordance with previously accepted submittals.

    b. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

    c. Do not use calcium chloride, salt, or other materials containing antifreeze agents unless otherwise specified and approved in mixture designs.

J. Hot-Weather Placement: Comply with ACI 305.1 and as follows:

1. When concrete is expected to be placed at air temperatures of greater than 80 deg F, contractor shall review with Architect all special procedures that will be used including mix design modifications and methods of protection. This review shall occur prior to the expected extreme temperatures.
2. Provide sufficient protection material and equipment on the Project site in advance of the time when the mean daily temperatures are expected to rise above 80 degrees F.
3. When air temperature exceeds 80 deg F, take special precautions to prevent slump loss, rapid setting, and plastic shrinkage; including but not limited to:

    a. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

    b. Use set retarding admixture in accordance with previously accepted submittals.

    c. Use microsynthetic fibers in the concrete mixture to minimize plastic shrinkage cracking.

    d. Convey, deposit, finish and commence curing of concrete as rapidly as practicable.

4. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.13 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections exceeding 1/4 inch.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:

1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match

adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.14 FINISHING FLOORS AND SLABS

A. Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in 1 direction.

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Finish surfaces to the following tolerances, according to ASTM E 1155, for a randomly trafficked floor surface:

   a. Specified overall values of flatness, F(F) 25; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and of levelness, F(L) 15. These values apply to all floors and slabs unless noted otherwise.

   b. Specified overall values of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17. These values apply to slabs-on-grade.

   c. Specified overall values of flatness, F(F) 30; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 15; for suspended slabs.

2. Slabs supporting modular office partitions, movable partitions, adhered flooring systems, or compact storage shelving must also comply with the manufacturer's tolerance requirements.
3. Slabs scheduled to receive wood flooring must also comply with tolerances required for installation of wood flooring. Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-foot long straightedge resting on 2 high spots and placed anywhere on the surface does not exceed 1/4 inch.
4. Fill or grind completed floors as necessary to achieve specified finish tolerances. Fill shall be with a self-leveling cementitious product capable of being tapered to a feathered edge.

a. Repair any floor section measuring below either the minimum local F-number or the minimum local L-number.

E. Trowel and Fine-Broom Finish: While concrete is still plastic, slightly scarify surface with a fine broom.

1. Comply with flatness and levelness tolerances for trowel finished floor surfaces.

F. Broom Finish: Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

G. Dry-Shake Floor Hardener Finish: After initial floating, apply dry-shake floor hardener to surfaces according to manufacturer's written instructions and as follows:

1. Uniformly apply dry-shake floor hardener at a rate of 100 lb/100 sq. ft. for the mineral aggregate hardener and at a rate of 150 lb/100 sq.ft. for the metallic and non-oxidizing metallic hardeners..
2. Uniformly distribute approximately two-thirds of dry-shake floor hardener over surface by hand or with mechanical spreader, and embed by power floating. Follow power floating with a second dry-shake floor hardener application, uniformly distributing remainder of material, and embed by power floating.
3. After final floating, apply a trowel finish. Cure concrete with curing compound recommended by dry-shake floor hardener manufacturer and apply immediately after final finishing.

H. Schedule of Concrete Finish Types, unless otherwise indicated on Drawings:

1. Formed Surfaces Not Exposed To View: Rough Formed.
2. Formed Surfaces Exposed To View At Building Interior: Smooth Formed.
3. Formed Surfaces Exposed To View At Building Exterior: Smooth Formed.
4. Formed Surfaces to Receive:

a. Paint: Grout Cleaned.

b. Waterproofing, Dampproofing: Smooth Formed.

c. Veneer Plaster: Smooth Formed.

5. Exposed Interior Slabs: Trowel.
6. Exposed Stair Fills and Ramps: Nonslip Aggregate.
7. Slabs to Receive:

a. Concrete Toppings: Float.

b. Mortar Setting Beds: Scratch.

c. Membrane Waterproofing: Float.

d. Fluid Applied Waterproofing: Trowel.

e. Resilient Flooring: Trowel.

f. Carpet: Trowel.

g. Tile (thin-set): Fine Broom.

8. Exposed to View Curbs: Provide monolithic finish by stripping forms while concrete is green and steel-troweling surfaces to a dense, hard, finish with corners intersections and terminations slightly rounded.

3.15 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by 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 at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel-finish concrete surfaces.

E. Post-Installed Concrete Anchors

1. Install in accordance with the manufacturer’s recommendations and ICC-ES reports.
2. Use washers on all bolts.
3. Use care to avoid cutting or damaging reinforcing bars.
4. When exposed to view in the final structure, bolts shall be of a length that will extend entirely through but not more than 1/4-inch beyond the nuts unless otherwise shown on the Drawings.

3.16 CONCRETE PROTECTING AND CURING

A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:.

1. Moisture Curing: Keep surfaces continuously moist for not less than seven (7) days with the following materials:

   a. Water.

   b. Continuous water-fog spray.

   c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven (7) days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

   a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.

   b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.

   c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a strippable or dissipating curing compound.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.
5. Interior slabs to receive resilient flooring: Cure only with moisture retaining cover. Strippable or dissipating curing compounds may be used on trowel finished surfaces.
6. Interior slabs to receive thin set of tile: Cure only with moisture retaining cover. Do not cure with curing compound.
7. Exterior Flatwork: Apply 1 coat of curing/sealing compound as soon as possible after finishing.

3.17 LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.

1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
2. Follow manufacturers written instructions.
3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.

B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

3.18 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least three month(s). Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.19 CONCRETE SURFACE REPAIRS

A. Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval. Repair and replacement work will be done at Contractor’s expense.

B. Defective Concrete is defined as concrete which is under strength, out of line, level or plumb, or shows objectionable cracks, honeycombing, rock pockets voids, spalling, exposed reinforcement, that has any sawdust, wood, or debris embedded in it, or is otherwise defective, and in the Architect's judgment these defects impair the proper strength or appearance of the work. Any concrete work not in accordance with the Specification and Drawings will be deemed to be defective.

C. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

D. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete, but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes

and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.

E. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
2. After concrete has cured at least 14 days, correct high areas by grinding.
3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with polymer patching mortar. Finish repaired areas to blend into adjacent concrete.
4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

F. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

G. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.20 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Inspections:

1. Steel reinforcement placement.
2. Steel reinforcement welding.
3. Headed bolts and studs.
4. Post-installed concrete anchors, per ICC-ES recommendations.
5. Verification of use of required design mixture.
6. Concrete placement, including conveying and depositing.
7. Curing procedures and maintenance of curing temperature.
8. Verification of concrete strength before removal of shores and forms from beams and slabs.

C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 150 cu. yd. or fraction thereof of, nor less than once for each 5000 sq. ft. of surface area for slabs or walls, each concrete mixture placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C231, pressure method, for normal-weight concrete; ASTM C173, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Water Content and W/cm: In accordance with AASHTO T318.
5. Concrete Temperature: ASTM C1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
6. Density: ASTM C567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
7. Compression Test Specimens: ASTM C31.

    a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.

8. Compressive-Strength Tests: ASTM C39; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.

    a. A compressive-strength test shall be the average compressive strength from a set of specimens obtained from same composite sample and tested at age indicated.

    b. Number of specimens in each set shall follow requirements of ACI 318 Section 5.

9. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi, when the specified strength is 5000 psi or less; or by more than 10 percent of specified strength, when the specified strength is above 5000 psi.
10. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28 -day tests.
11. Monthly charts and compressive strength, w/cm and air content will be sent to all parties on the pre-concrete conference distribution list.
12. Non-compliant Test Reports: All test reports indicating non-compliance should be e-mailed or faxed immediately to all parties on the test report distribution list. Copies shall be distinguishable from the originals.
13. Nondestructive Testing: Rebound hammer, ultrasonic, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
14. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42 or by other methods as directed by Architect.

    a. If test results indicate that compressive strength requirements have not been met, the Contractor shall justify that the load carrying capacity of the structure has not been reduced. Carry out tests of cores drilled from the area in question as directed by the Architect in accordance with ASTM C42 and ACI 318 Section 5.6.5.

    b. If the compressive tests of the core specimens fail to show the compressive strength specified, the concrete shall be deemed defective and shall be replaced or adequately strengthened in a manner acceptable to the Architect. Perform load tests as outlined in ASTM C39, as directed by the Architect, on the questionable portion of the Work.

15. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
16. Correct deficiencies in the Work that test reports and inspections indicate dos not comply with the Contract Documents.

D. Reinforcing Steel

1. Notify the testing agency and the Architect at least 48 hours before concrete is to be poured or reinforcing is covered up.
2. Before any concrete is poured on any particular portion of the building, the reinforcing steel and form dimensions will be inspected by the Testing Agency. Any errors or discrepancies shall be corrected before concrete is placed.

3. As a minimum, all testing and inspection as per the requirements of the New York City Building Code. Reinforcing steel to be assumed to have been designed for calculated stresses in excess of 70 percent of the basic allowable values.
4. In addition to other required inspections, the following are subject to Special Inspection as per IBC Chapter 1704.4:

    a. Placement of Reinforcing Steel

    b. Welding of Reinforcing Steel

5. A special inspector from the Testing Agency shall be present during all field bending of reinforcement.
6. Installation of deformed bar anchors to be tested in accordance with Section 7.1 of AWS D1.1.
7. Welding of Reinforcement: There shall be continuous inspection during all welding of reinforcement. All butt welds to be inspected using radiographic testing. At the Owners option recognized non-destructive tests such as resistance, Magnetic Particle Examination, and Liquid Penetrant Inspection may be used to inspect the welds.
8. Comply with ICC-ES approvals with respect to special inspection required during installation.
9. Testing and inspection of mechanical splices and reinforcing couplers to conform to manufacturer's recommendations and ICC-ES approval.

E. Survey and Adjustment: Continuously observe formwork operations, record such observations on a daily basis, and submit reports of the results. Instrument check forms before and during concrete placement to assure no movement has taken place. Make appropriate corrections to reposition displaced forms.

1. Measure floor and slab flatness and levelness according to ASTM E1155 within 48 hours of finishing.
2. Certify, by written report submitted on a weekly basis, for each level and story that the elevations, finish lines and building lines of the hardened concrete are within tolerances, as substantiated by transit survey; also that all embeds and inserts have been installed within tolerance.

3.21 PROTECTION OF LIQUID FLOOR TREATMENTS

A. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION

SECTION 033055
CAST-IN-PLACE CONCRETE (SITE)

PART 1 – GENERAL

1.01 DESCRIPTION

A. This Section specifies requirements for concrete cast-in-place on the site.

B. The work includes cast-in-place concrete pavement, walkway bases, and thrust blocks.

1.02 RELATED SECTIONS

A. Sections which directly relate to the work of this Section include:

1. Section 310000 – EARTHWORK
2. Section 321610 – CURBING

1.03 REFERENCE STANDARDS

A. References herein are made in accordance with the following abbreviations and all work under this Section shall conform to the latest editions as applicable.

1. American Concrete Institute (ACI):

301	Specifications for Structural Concrete
305R	Hot Weather Concreting
306R	Cold Weather Concreting
325.9R	Guide for Construction of Concrete Pavements and Concrete Bases

2. ASTM International (ASTM):

A82	Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
A1064	Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
C33	Standard Specification for Concrete Aggregates
C94	Standard Specification for Ready-Mixed Concrete
C143	Standard Test Method for Slump of Hydraulic-Cement Concrete
C150	Standard Specification for Portland Cement
C171	Standard Specification for Sheet Materials for Curing Concrete
C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
C260	Standard Specification for Air-Entraining Admixtures for Concrete
C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
C494	Standard Specification for Chemical Admixtures for Concrete

C1116 Standard Specification for Fiber-Reinforced Concrete

3. Concrete Reinforcing Steel Institute (CRSI):
   Manual Manual of Standard Practice.

4. United States Department of Justice - Americans with Disabilities Act (ADA):
   ADA ADA Accessibility Guidelines for Buildings and Facilities; 28 CFR Part 36.

5. New York State Regulations regarding Accessibility.

1.04 QUALITY ASSURANCE

A. Work and materials for construction of the cement concrete walks shall conform to ACI 316R. Other cast-in-place concrete shall conform to ACI 301.

B. Work, materials, and color of the wheelchair ramp paving shall conform to applicable sections of Americans with Disabilities Act (ADA) and State Standards, whichever is more stringent.

C. Dimensions, locations, and details of equipment pads, anchors, supports, and similar features shown on the Drawings are approximate. Manufacturer's approved shop Drawings of equipment to be supported, anchored, or contained thereby shall be consulted for exact location, size, and details.

1.05 SUBMITTALS

A. Submit description of methods and sequence of placement for each type of specially finished concrete, including description of methods and sequence of placement.

B. Submit manufacturer's product data for the following:

1. Form release agent.
2. Preformed joint filler.
3. Concrete reinforcement specification data from manufacturer.
4. Detectable Warning including manufacturer’s certification that product complies with ADA

1.06 TESTING

A. The Owner may employ an independent testing laboratory to inspect and test concrete paving and other cast-in-place concrete work.

B. When requested, Contractor shall prepare test specimens in accordance with ASTM C31, standard cylinder size 4-inch x 8 inch.

C. Testing of materials and installed work may occur at any time during progress of the work. Rejected materials and installed work shall be removed and replaced.

PART 2 – PRODUCTS

2.01 STEEL REINFORCEMENT

A. Steel reinforcing bars shall conform to ASTM A615, Grade 60, deformed.

1. Bars employed as dowels shall be hot-rolled plain rounds.

B. Steel Wire: ASTM A82, plain cold drawn steel.

C. Welded Wire Reinforcement: Welded wire reinforcement shall conform to the applicable requirements of ASTM A1064. Fabric reinforcement shall be furnished in flat sheets. Fabric reinforcement in rolls will not be permitted.

D. Supports for Reinforcement: Bolsters, chairs, and other devices for spacing, supporting, and fastening reinforcing bars, and welded wire fabric in place shall be wire bar-type supports complying with CRSI Manual.

1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.
2. For exposed-to-view concrete surfaces where legs of supports are in contact with forms, provide supports with legs that are protected by plastic (CRSI Class 1).

2.02 PORTLAND CEMENT CONCRETE

A. Portland cement concrete shall conform to the following:

1. Maximum water-cement ratio shall be 0.45 conforming to ACI 316R.
2. Concrete shall be air-entrained type conforming to ASTM C94. Air content by volume shall be 6 percent + 1.5 percent, tested in accordance with ASTM C260.
3. Slump of concrete shall not be less than 3 inches nor greater than 4 inches, determined in accordance with ASTM C143.
4. Cement for concrete shall be a Portland cement conforming to ASTM C150, Type I or II. Only one color of cement, all by the same manufacturer, shall be used for the work.
5. Fine and coarse aggregates for concrete shall conform to ASTM C33.
6. Concrete shall contain a water reducing agent to minimize cement and water content of the concrete mix at the specified slump. Water reducing agent shall conform to ASTM C494, Type A.
7. Concrete shall contain no calcium chloride or admixtures containing calcium chloride. No admixtures other than those specified shall be used in the concrete without the specific written permission of the Engineer.

2.03 CONCRETE AGGREGATES

A. Fine Aggregates: Fine aggregates shall conform to ASTM C33, part 6.

B. Coarse Aggregates: Coarse aggregates shall conform to ASTM C33, Parts 9 through 11 and Tables 2 and 3, with the following Class designations:

1. Class 4S: For pavements, driveways, curbs, walkways, sidewalks, and retaining walls that are exposed to the weather.
2. Class 1N: For pavements, driveways, curbs, walkways, sidewalks, and retaining walls that are not exposed to the weather.

C. Exposed Aggregate: Exposed aggregate for ADA curb ramps shall be selected, hard, durable, washed rounded stones free of deleterious reactivity to cement with graded sizes between 1/2 to 3/4-inch diameter nominal sieves.

2.04 CURING MATERIALS FOR UNCOLORED CONCRETE

A. Curing shall be accomplished by the following methods:

1. Moist curing with burlap covering.

2. Curing paper, non-staining, fiber reinforced laminated Kraft bituminous product conforming to ASTM C171. Four mil polyethylene sheeting may be substituted for curing paper.
3. Curing compound, a resin-base, white pigmented compound conforming to ASTM C309, Type 2.

2.05 EXPANSION JOINTS

A. Expansion joint filler shall be preformed, non-bituminous type conforming to ASTM D1752, Type II, similar to Sealtight Cork Expansion Joint Filler, manufactured by W.R. Meadows, Inc., Elgin, IL 60120, or approved equivalent.

1. Pre-molded filler shall be one piece for the full depth and width of the joint.

B. Smooth dowel shall be hot rolled plain steel dowel bonded at one end and operating in smooth close-fitting sleeve (of same material) at the other end.

2.06 CONTROL JOINTS

A. Joint filler to be polyethylene foam with manufacturer's recommended sealant.

2.07 FORMS

A. Cylindrical Forms: Sonotube Fibre Forms, wax-impregnated strippable forms manufactured by Sonoco Products Company, General Products Division, ABS or PVC plastic reusable forms, or approved equivalent.

B. Forms for Exposed Finish: Plywood, metal, metal-framed plywood faced, or other acceptable panel materials. Plywood shall conform to U.S. Product Standard PS-1 and APA Graded B-B (Concrete Form) Class I Exterior Grade plywood or B-B or A-C Class I high density overlay concrete form plywood. Formwork materials shall produce smooth, continuous, straight and level surfaces.

C. Forms for Unexposed Finish: Plywood, lumber, or metal, with lumber dressed on at least two edges and one side.

D. Form Ties: Prefabricated, adjustable length galvanized steel snap-off ties, with brackets, cones, cornerlocks, and other accessories as necessary.

E. Form Release Agent: Commercial formulation compounds that will not bond with, stain or adversely affect concrete.

F. Imprinting Tools: Mats and tools used to stamp projecting texture and patterns onto plastic concrete surfaces and which shall be specifically designed with rigid back supports to enable a clean, sharp, stamping image. Stamps for curb ramps shall be designed to meet ADA detectable warning requirements.

2.08 FIBROUS REINFORCING

A. Material shall meet ASTM C1116 and shall be as manufactured by NyCon Incorporated, or approved equal.

B. Mix fibrous reinforcement in accordance with manufacturer's instructions including product data and technical bulletins.

1. Add fibrous reinforcement to concrete mix at the concrete batch facility.
2. Adding and mixing fibrous reinforcement at the job site will not be allowed.

C. Provide job mix design data to show concrete mix will attain specified strength requirements.

2.09 EXPOSED CONCRETE PROTECTIVE COATING

A. Surface sealer shall be silane-siloxane non-yellowing type which breathes water vapor, Saltguard WB by ProSoCo or approved equivalent.

2.10 DETECTABLE WARNINGS

A. Detectable warnings shall meet ADA and State Standards, whichever is more stringent, and shall be ADA Solutions Cast-in-Place Replaceable Tactile Warning Surface Tiles Federal Yellow (or approved equal).

PART 3 – EXECUTION

3.01 PREPARATION OF SUBGRADE

A. The subgrade of areas to be paved shall be graded and compacted as specified in Section 321100, BASE COURSES (PAVEMENTS).

B. Excavation required in pavement subgrade shall be completed before fine grading and final compaction of subgrade are performed. Where excavation must be performed in completed subgrade, subbase, base, or pavement, subsequent backfill and compaction shall be performed as required by the Engineer and as specified in Section 310000, EARTHWORK.

C. Materials shall not be stored or stockpiled on subgrade.

D. Prepared subgrade will be inspected by the Engineer. Subgrade shall be approved for installation of the gravel base course. Disturbance to subgrade caused by inspection procedures shall be repaired.

3.02 BASE COURSE

A. Base course for concrete paving shall be pavement subbase course or gravel base materials specified in Section 321100, BASE COURSES (PAVEMENTS) as shown on the Drawings.

B. Width of base course shall extend beyond edge of the proposed pavement as shown on the Drawings.

C. Material shall be placed in lifts no more than 6 inches thick, compacted measure. Each lift shall be separately compacted to specified density.

1. Material shall be placed adjacent to wall, manhole, catch basin, and other structures only after they have been set to required grade.
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 inch as measured by means of a 10-foot-long straightedge shall be regraded and recompacted.

D. Base course shall be compacted at optimum moisture content to not less than 95 percent of maximum density as determined by ASTM D1557.

E. The base course shall be kept clean and uncontaminated. Less select materials shall not be permitted to become mixed with the base course material.

3.03 STEEL REINFORCEMENT

A. Before being placed in position, reinforcing steel shall be thoroughly cleaned of loose mill and rust scale, dirt, ice, and other foreign material which may reduce the bond between the concrete and reinforcing. Where there is delay in placing concrete after reinforcement is in place, bars shall be re-inspected and cleaned when required.

B. Any bar showing cracks after bending shall be discarded.

C. Unless otherwise shown on the Drawings, reinforcing shall extend within 2 inches of formwork and expansion joints. Reinforcing shall continue through control joints. Adjacent sheets of fabric reinforcing shall lap 6 inches.

D. After forms have been coated with form release agent, but before concrete is placed, reinforcing steel shall be securely wired in the required position and shall be maintained in that position until concrete is placed and compacted. Chair bars and supports shall be installed in a number and arrangement approved by the Engineer.

3.04 FORMS

A. General: Design, erect, support, brace, and maintain formwork to support vertical, lateral, static, and dynamic loads that might be applied until concrete structure can support such loads. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position. Maintain formwork construction tolerances and surface irregularities complying with the following ACI 347 limits.

1. Provide Class A tolerances for concrete surfaces exposed to view.
2. Provide Class C tolerances for other concrete surfaces.

B. Construct forms to provide for openings, offsets, sinkages, keyways, recesses, moldings, chamfers, blocking, screeds, bulkheads, anchorages, and inserts, and other features required for the work. Use selected materials to obtain required finishes. Solidly butt joints and provide back-up at joints to prevent cement paste from leaking.

C. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Kerf wood inserts for forming keyways, reglets, recesses, and other features for easy removal.

D. Chamfer exposed corners and edges, using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.

E. Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before placing concrete. Re-tighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

3.05 INSTALLING EMBEDDED ITEMS

A. General: Set and build into formwork the anchorage devices and other embedded items required for 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.

B. Forms for Slabs: Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and contours in finished surfaces. Provide and secure units to support screed strips using strike-off templates or compacting-type screeds.

3.06 PREPARING FORM SURFACES

A. Coat contact surfaces of forms with an approved, nonresidual, low-VOC form-coating compound before placing reinforcement.

3.07 CONCRETE PLACING

A. Equipment, methods of mixing and placing, and precautions to be observed as to weather, and condition of base shall meet the requirements of ACI 316R.

B. The Engineer shall be notified of scheduled concrete placement sufficiently in advance of start of operation to allow preliminary inspection of the work, including subgrade, forms, and reinforcing steel.

C. Work shall not be performed during rainy weather or when temperature is less than 40°F. (4.4°C.).

D. Adjacent work shall be protected from stain and damage. Damaged and stained areas shall be replaced or repaired to equal their original conditions.

E. Existing concrete, earth, and other water-permeable material against which new concrete is to be placed shall be thoroughly damp when concrete is placed. There shall be no free water on surface.

F. Concrete which has set or partially set, before placing shall not be used. Retempering of concrete will not be permitted.

G. Concrete shall be thoroughly vibrated, or otherwise consolidated to secure a solid and homogeneous mass, thoroughly worked around reinforcement and into corners of forms.

H. When joining fresh concrete to concrete which has attained full set, latter shall be cleaned of foreign matter, and mortar laitance shall be removed by chipping and washing. Clean, roughened base surface shall be saturated with water, but shall have no free water on surface. A coat of 1:1 cement-sand grout, approximately 1/8 inch thick, shall be well scrubbed into the thoroughly dampened concrete base. New concrete shall be placed immediately, before grout has dried or set.

3.08 FINISHING

A. Concrete surfaces shall be screeded and finished true to line and grade, and free of hollows and bumps. Surface shall be dense and smooth.

1. Finished concrete surface for concrete subbases shall be wood floated to a slightly rough surface. Surface shall not deviate more than 1/4 inch in 10 feet.
2. Finished concrete surfaces shall be wood floated and steel troweled, or broom finished, to a uniform surface. Surface shall not deviate more than 1/8 inch in 10 feet.

B. Horizontal surfaces of concrete surfaces which will be exposed shall be given a light broomed finish, with direction of grooves in concrete surface perpendicular to length of concrete band, slab, or pad. After concrete has set sufficiently to prevent coarse aggregate from being torn from surface, but before it has completely set, brooms shall be drawn across the surface to produce a pattern of small parallel grooves. Broomed surface shall be uniform, with no smooth, unduly rough or porous spots, or other irregularities. Coarse aggregate shall not be dislodged by brooming operation.

C. Immediately following finishing operations, arises at edges and both sides of expansion joints shall be rounded to a 1/4- inch radius. Control joints to be tooled shall be scored into slab

surface with scoring tool. Adjacent edges of control joint shall at same time be finished to a 1/4-inch radius.

D. Where finishing is performed before end of curing period, concrete shall not be permitted to dry out, and shall be kept continuously moist from time of placing until end of curing period, or until curing membrane is applied.

E. Sidewalks, walkways, accessible routes, and ramps shall be constructed and finished in accordance with the Americans with Disabilities Act (ADA) and state and local requirements. Provide protective coating in accordance with manufacturer's recommendations.

F. Exposed Aggregate Finish: Expose coarse aggregate in pavement surfaces as follows:

1. Immediately after float finishing, spray-apply chemical surface retarder to pavement according to manufacturer's written instructions.
2. Cover pavement surface with plastic sheeting, sealing laps with tape, and remove when ready to continue finishing operations.
3. Without dislodging aggregate, remove excess mortar by lightly brushing surface with a stiff, nylon-bristle broom.
4. Fine-spray surface with water and brush. Repeat water flushing and brushing cycle until cement film is removed from aggregate surfaces to depth required.

3.09 STAMPING

A. Mat Stamping: While initially finished concrete is plastic accurately align and place stamp mats in sequence. Uniformly load mats and press into concrete to produce requirement imprint pattern and depth of imprint on concrete surface. Remove stamp mats immediately. Hand stamp edges and surfaces unable to be imprinted using stamp mats.

B. Tool Stamping: While initially finished concrete is plastic, cover surface with polyethylene film, stretch taut to remove wrinkles, lap sides and ends 3 inches (75 mm), and secure to edge forms. Lightly broom surface to remove air bubbles. Accurately align and place stamp tools in sequence and tamp into concrete to produce required imprint pattern and depth of imprint on concrete surface. Remove stamp tools immediately. Hand stamp edges and surfaces unable to be imprinted by stamp tools. Unroll and remove polyethylene film immediately after tool stamping.

3.10 CURING

A. Concrete shall be kept continuously damp from time of placement until end of specified curing period or cured by other methods. Water shall not be added to surface during floating and troweling operations, and not earlier than 24 hours after concrete placement. Between finishing operations, surface shall be protected from rapid drying by a covering of waterproofing paper. Surface shall be damp when the covering is placed over it, and shall be kept damp by means of a fog spray of water, applied as often as necessary to prevent drying, but not sooner than 24 hours after placing concrete. None of the water so applied shall be troweled or floated into surface.

B. Concrete surfaces shall be cured by completely covering with curing paper or application of a curing compound.

1. Concrete cured using waterproof paper shall be completely covered with paper with seams lapped and sealed with tape. Concrete surface shall not be allowed to become moistened between 24 and 36 hours after placing concrete. During curing period, concrete surface shall be checked frequently, and sprayed with water as often as necessary to prevent drying, but not earlier than 24 hours after placing concrete.

2. Concrete cured with a curing compound shall have the compound applied at a rate of 200 square feet per gallon, in two applications perpendicular to each other.
3. Curing period shall be seven (7) days minimum.

C. Only if additional protection is absolutely required, the surface should remain uncovered after the seven (7) day period for at least four (4) days, after which time new and unwrinkled non-staining reinforced waterproof Kraft curing paper may be used.

3.11 EXPANSION JOINTS

A. Expansion joints shall be 1/2-inch-wide and located to provide a maximum spacing of 30 feet between joints or where shown on the Drawings. Expansion joints shall be troweled in the concrete to required width with preformed joint filler in place. Joint filler shall extend the full depth of the slab and full length of the expansion joint.

1. For concrete walks, pavements, and pads, depth of joint filler shall be placed to form a 1-1/4 inch deep recess for sealant and backer rod below finished concrete surface.
2. Use of multiple pieces to make up required depth and width of joint will not be permitted.

3.12 CONSTRUCTION JOINTS

A. Construction joints shall be placed whenever placing of concrete is suspended for more than 30 minutes.

1. Butt joint with dowels or use a thickened edge joint if construction joints occur at control joint locations.
2. Keyed joints with tie-bars shall be used if the joint occurs at any other location.

3.13 CONTROL JOINTS

A. Control joints shall be tooled into the concrete slab, with 3-inch wide border and troweled edges, in pattern as shown on the Drawings. If no pattern is shown, then pattern shall result in square shape with a maximum area of 36 square feet. Joints shall be made after concrete is finished and when the surface is stiff enough to support the weight of workmen without damage to the slab, but before slab has achieved its final set.

B. Scoring shall cut into slab surface at least 1 inch, but in no case not less than 25 percent of slab depth.

3.14 PROTECTIVE COATING

A. Sealant shall be applied per manufacturer’s recommendations

3.15 COLD WEATHER CONCRETING

A. Materials for concrete shall be heated when concrete is mixed, placed, or cured when the mean daily temperature is below 40°F. or is expected to fall to below 40°F. within 72 hours. The concrete, after placing, shall be protected by covering, heat, or both.

B. Details of handling and protecting of concrete during freezing weather shall be subject to the approval and direction of the Engineer. Procedures shall be in accordance with provisions of ACI 306R.

3.16 HOT WEATHER CONCRETING

A. Concrete just placed shall be protected from the direct rays of the sun and the forms and reinforcement just prior to placing shall be sprinkled with cold water. Every effort shall be made to minimize delays which will result in excessive mixing of the concrete after its arrival on-site.

B. During periods of excessively hot weather (95°F., or above), ingredients in the concrete shall be cooled with cold mixing water to maintain the temperature of the concrete at permissible levels in accordance with the provisions of ACI 305R. Any concrete with a temperature above 95°F., when ready for placement, will be rejected.

C. Temperature records shall be maintained throughout the period of hot weather giving air temperature, general weather conditions (calm, windy, clear, cloudy, etc.) and relative humidity. Records shall include checks on temperature of concrete when delivered to Project site and after placing in forms. Data should be correlated with the progress of the work so that conditions surrounding the construction of any part of the structure can be ascertained.

3.17 PROTECTION OF CONCRETE SURFACES

A. Concrete surfaces shall be protected from traffic or damage until surfaces have hardened sufficiently.

3.18 DETECTABLE WARNINGS

A. Detectable warnings shall be installed at locations as shown on plans and per manufacturer's recommendations.

END OF SECTION 033055

SECTION 033315

ARCHITECTURAL TOPPING SLABS

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 topping slabs.

1.3 REFERENCES

A. ASTM C 109, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars.

B. ASTM C 309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

C. ASTM C 348, Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars.

D. ASTM C 779, Standard Test Method for Abrasion Resistance of Horizontal Concrete Surfaces.

E. ASTM C 1028, Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method.

F. ASTM C 1315, Liquid Membrane-Forming Compounds Having Special Properties of Curing and Sealing Concrete.

G. ASTM E 430, Standard Test Method for Measurement of Gloss of High-Gloss Surfaces by Abridged Goniophotometry.

H. ASTM F 710, Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.

I. ASTM F 1869, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.

J. ASTM F 2170, Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.

K. ACI 302.1R-04, Guide for Concrete Floor and Slab Construction.

1.4 SUBMITTALS

A. General: Submit samples and manufacturer's product data sheets, installation instructions, maintenance procedures, project references, etc. in accordance with "Submittal Procedures" Section.

B. Test Data: Submit qualified testing data that confirms compliance with specified performance requirements.

C. Maintenance Data

1. Include manufacturer's instructions for maintenance of installed work, including methods and frequency recommended for maintaining optimum condition under intended use.

2. Include precautions against cleaning products and methods which may be detrimental to finishes and performance.

1.5 QUALITY ASSURANCE

A. Qualifications

1. Manufacturer:

a. Must have marketed fast-setting, high strength, cementitious, polishable materials in the United States for at least five years and must have completed projects of the same general scope and complexity.
b. Overlay and complementary materials must be manufactured by or approved for use by manufacturing.

2. Applicator

a. Must be experienced and competent in installation of fast-setting, high strength, cementitious, polishable materials and provide evidence of a minimum of five years experience in work similar in size and scope to that required by this section.
b. Must retain sufficient production capability, facilities, and personnel to produce specified work.
c. Must provide proof of current Approved Applicator status from the overlay materials manufacturer. Temporary approvals must be approved in writing by an authorized Technical Representative at least 15 days prior to installation and are required to have an authorized Representative on site for initial application.

B. Samples:

1. Submit samples for approval. Samples must be of materials specified and of suitable size as required to accurately represent each color and texture used on project. Prepare each sample using the same tools and techniques for actual project application.

2. Maintain and make approved samples available at the job site throughout the construction process and until final acceptance.

3. Mock-Up: Provide 3 mock-ups of the complete system sample panel, sized 6' x 6', using workmen, equipment, and techniques proposed for use on the project.

a. Mock-up must be reviewed for uniformity of depth and thickness, finish color and texture, and overall quality of construction.
b. The approved panel will become the standard of comparison for finished work for the project.
c. The approved panel must remain on site throughout the construction process and until final acceptance.
d. Approved mock-up may become part of the completed work if undisturbed at time of substantial completion.
e. Upon project completion and final acceptance, dispose of the sample in accordance with local construction waste guidelines.

C. Walkway Auditor: Certified by CPAA or NFSI to test polished concrete floors for dynamic and static coefficient of friction according to ANSI B101.1 and B101.3.

D. Coefficient of Friction: Achieve following coefficient of friction by field quality control testing in accordance to the following standards:

1. ANSI B101.1 Static Coefficient of Friction - Achieve a minimum of [.5] for level floor surfaces.

2. ANSI B101.3 Dynamic Coefficient of Friction - Achieve a minimum of [.35] for level floor surfaces.

1.6 PRE-INSTALLATION MEEETINGS

A. Pre-installation Conference: Conduct conference at the Project Site at least two (2) weeks prior to initial overlay placement.

B. Organize meeting to review specification requirements and finished aesthetics. Require representatives of each entity directly concerned to attend, including the following:

1. Owner.

2. Architect.

3. Contractor's Superintendent/Supervisor.

4. Overlay and Polishing Subcontractor(s), including Finishers and Supervisor.

5. Complementary Hardeners, Sealers, Colorants Manufacturer(s).

6. Overlay Manufacturer's Representative.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver products in original, unopened, undamaged packaging with manufacturer's identification (i.e., brand logo, product name, weight of packaged unit, lot number). Maintain records of manufacturer’s product lot numbers.

B. Storage: Store products in a dry location, covered, out of direct sunlight, off the ground, and protected from moisture. Maintain storage temperature required by the manufacturer. Keep materials dry until used. Store bulk sand in a well-drained area on a clean, solid surface. Cover sand to prevent contamination. Protect materials from temperature extremes.

C. Handling: Handle products in accordance with manufacturer's published recommendations.

1.8 SITE/ ENVIRONMENTAL CONDITIONS

A. Temperature: Maintain ambient and surface temperatures between 50°F (10°C) to 90°F (32°C). Do not apply materials if ambient temperature falls below 50ºF (10ºC) within 24 hours of application. Protect materials from uneven and excessive evaporation during dry weather, windy conditions and strong blasts of dry air.

B. Inclement Weather: Do not apply materials during inclement weather unless appropriate protection is employed.

C. Sunlight Exposure: Avoid, whenever possible, installation of materials in direct sunlight which could adversely affect aesthetics.

D. Substrate: Prior to installation, the substrates must be inspected for surface contamination or other conditions that may adversely affect the performance of the materials and be free of residual moisture.

E. Comply with manufacturer's written instructions for substrate temperature and moisture content, ambient temperature and humidity, ventilation and other conditions affecting product performance.

F. Damage and Stain Prevention: Take precautions to prevent damage and staining of substrates and surfaces to be polished before and after installation.

1. Protect areas to receive polished topping at all times to prevent oils, dirt, metal, excessive water and other potentially damaging materials from affecting the finished surface.

2. Prohibit use of markers, spray paint, and soapstone.

3. Prohibit vehicle traffic over surfaces. If necessary to complete a scope of work, drop cloths or other suitable materials must be placed under vehicles at all times.

4. Prevent staining by hydraulic-powered equipment fluids.

5. Prohibit steel from being placed on the finished surface to avoid rusting.

6. Prohibit pipe-cutting operations over surfaces.

7. Prohibit ferrous metals storage over surfaces.

8. Protect from petroleum, oil, hydraulic fluid, or other liquid dripping from equipment working over surfaces.

9. Protect from acids and acidic detergents contacting substrates and surfaces to be polished.

10. Protect from painting activities.

11. All trades must be informed that the surfaces must be protected at all times.

12. Installed topping area must be closed to traffic during finish floor application and after application for the length of time recommended by the manufacturer.

1.9 COORDINATION AND SCHEDULING

A. Coordinate installation of materials with all other trades to avoid impeding other construction.

B. Sufficient manpower must be provided to ensure continuous application and timely finishing.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: CTS Cement Manufacturing Corp., 11065 Knott Avenue, Cypress, CA 90630; tel: (800) 929-3030, www.CTScement.com

B. Color additive: E & A Supply.

C. Components: Obtain overlay and complementary materials manufactured by CTS Cement from authorized distributors. No substitutions or additions of other materials are permitted without prior written permission from the manufacturer for this project.

2.2 MATERIALS

A. Fast Setting, High Strength, Cementitious Polishable Overlay: Rapid Set TRU PC, pre-packaged, high-performance, fast-setting, high-flow, self-leveling cementitious, polishable overlay material mixed with water and decorative aggregate on site. Product shall be ready for foot traffic in 2 to 3 hours; coatings in 12 hours; grind and polish in 24 hours.

B. Primer: Rapid Set TXP FAST, high-performance, 100% solids, no VOC, fast-curing, moisture-tolerant, interior epoxy primer designed for use with cementitious overlays. Provides high bond strength to ensure strong adhesion. Ready for overlay in 6 hours.

C. Additives and admixture materials must be approved for use by CTS Cement Manufacturing Corp. prior to use.

D. Water: Clean, potable water free of deleterious amounts of silt and dissolved salts.

2.3 MATERIAL PERFORMANCE

A. Fast Setting, High Strength, Non-Shrink Cementitious Polishable Overlay

1. Minimum performance requirements:

Compressive Strength (ASTM C109 Modified*)	4 hours 24 hours 28 days	2,800 psi 5,000 psi 7,000 psi
Tensile Strength (ASTM C307 Modified*)	7 Days 28 Days	210 psi, minimum 365 psi, minimum

**Data obtained at flow consistency at 70°F (21°C)*

B. Finished Sheen/Gloss Level

1. As selected by Architect.

C. Floor Flatness and levelness requirements are:

1. Composite FF = no less than 50.

2. Composite FL : no less than 50

2.4 AGGREGATES

A. Fine and coarse aggregates must conform to ASTM C 33.

B. Lightweight aggregates must conform to ASTM C 330.

C. Decorative Broadcast Aggregates: As selected by Architect

D. Provide aggregates from a single source with a documented satisfactory service record for at least 10 years in similar applications and service conditions using similar aggregates and cementitious materials.

2.5 RELATED MATERIALS

A. Repair Materials: Products designed to repair cracks and surface imperfections prior to application of overlay material.

1. Rapid Set LevelFlor, quick-setting, hydraulic-cement-based, self-leveling floor underlayment.

2. Applied at 2.5 inches.

3. Rapid Set Cement All, pre-packaged, high-performance, fast-setting, multi-purpose, non-metallic, cementitious, non-shrink grout and concrete repair material mixed with water on site. Suitable for use in wet environments and any application where high durability and rapid strength gain are desired. Structural strength is achieved in one (1) hour. Suitable for structural and non-structural applications. Applied at 0 to 4" depth.

4. Rapid Set Mortar Mix, pre-packaged, trowel grade, high-performance, fast-setting, multi-purpose, non-metallic, cementitious repair material [with integral air entrainment] mixed with water on site. Suitable for indoor and outdoor use, use in wet environments, and for any application where high durability, rapid strength gain and low shrinkage are desired. Structural strength is achieved in one (1) hour. Suitable for structural and non-structural applications from 1/2 in. to 6 in. depths. Applied at 0.5" to 6" depth.

5. Rapid Set Concrete Mix, pre-packaged, trowel grade, high-performance, fast-setting, multi-purpose, non-metallic, cementitious repair material [with integral air entrainment] mixed with water on site. Suitable for indoor and outdoor use, use in wet environments, and for any application where high durability, rapid strength gain and low shrinkage are desired. Structural strength is achieved in one (1) hour. Suitable for structural and non-structural applications from 2 in. to 24 in. depths. Applied at 2 to 24" depth.

6. Metzger/McGuire Rapid Refloor, 100% solids, two-component, low-viscosity structural polyurea/polyurethane hybrid intended for use in repairing cracks and small surface defects such as bolt holes and pop-outs in industrial, retail or commercial concrete floors.

B. Liquid Densifier: An aqueous solution of Silicon Dioxide dissolved in one of the following Hydroxides that penetrates into the concrete surface and reacts with the Calcium Hydroxide to provide a permanent chemical reaction that hardens and densifies the wear surface of the cementitious portion of the concrete. All of the following have the same chemistry varying only by the alkali used for solubility of the Silicon Dioxide.

1. Sodium Silicate.

2. Potassium Silicate.

3. Lithium Silicate.

4. Alkalis solution of Colloidal Silicates or Silica.

C. Admixtures: Must conform to ASTM C 494. All additives and admixture materials must be approved for use by CTS Cement Manufacturing Corp. prior to use.

D. Sand: Washed and kiln dried angular cut #20 - #30 grit silica sand for use with primer.

E. Installation Accessories: Gauge rakes, spreaders or rollers for overlay placement. Use Rapid Set Spike Rollers to remove entrapped air.

2.6 PIGMENTS/COLORANTS (E & A SUPPLY)

A. Must comply with ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures and be color stable, [free of carbon black,] nonfading, and resistant to lime and other alkalis.

B. Dye: Non-film forming soluble colorant dissolved in a carrier designed to penetrate and alter coloration and appearance of a concrete floor surface without a chemical reaction. Color(s): As selected by the Architect.

C. Pigmented Micro Stains: Fine pigment particles (<3.9 x 10-4 inches) suspended in water-based silicate solution that penetrates concrete and reacts with calcium hydroxide to lock in color particles. Color(s): As selected by the Architect.

2.7 SEALERS/GUARDS

A. Sealer - Semi Impregnating Stain Protection: A film forming material which will penetrate into the polished and densified concrete leaving a protective surface film of less than .05 mils which meets the OSHA requirements for slip resistance as tested by ASTM D 2047 and stain resistance of ASTM D 1308. Color(s): As selected by the Architect.

B. Sealer - Impregnating Stain Protection: Non-film forming stain and food resistant penetrating sealer designed to be applied to densified and polished concrete which meets the requirements of OSHA for slip resistance as tested by ASTM D 2047 and stain resistance of ASTM D 1308. Color(s): As selected by the Architect.

2.8 JOINT AND CRACK FILL MATERIALS

A. Saw Cut Contraction/Construction Joint Filler and Crack Filler

1. Metzger/McGuire Spal-Pro RS 88 Semi-Rigid Polyurea Joint Filler.

2. Metzger/McGuire MM-80/MM-80P Semi-Rigid Polyurea Joint Filler.

3. Metzger/McGuire Rapid Refloor.

B. Color to match adjacent finished floor surface.

2.9 POLISHING EQUIPMENT

A. Field Grinding and Polishing Equipment:

1. A multiple-head, counter-rotating, walk-behind or ride-on machine, of various size and weights, with diamond tooling affixed to the head for the purpose of grinding concrete. Excludes janitorial maintenance equipment.

a. Minimum three (3) head counter rotating, variable speed floor grinder with at least 600 pounds of down pressure.

2. If dry grinding, honing, or polishing, use dust extraction equipment with flow rate suitable for dust generated, with squeegee attachments.

3. If wet grinding, honing, or polishing, use slurry extraction equipment suitable for slurry removal and containment prior to proper disposal.

B. Edge Grinding and Polishing Equipment: Hand-held or walk-behind machines with dust extraction attachments and pads which produces same results, without noticeable differences, as field grinding and polishing equipment.

C. Burnishing Equipment: High speed walk-behind or ride-on machines capable of generating 1000 to 2000 revolutions per minute and with sufficient head pressure of not less than 20 pounds to raise floor temperature by 20 degrees F.

D. Diamond Tooling: Abrasive tools that contain industrial grade diamonds within a bonded matrix (such as metallic, resinous, ceramic, etc.) that are attached to rotating heads to refine the concrete substrate.

1. Bonded Abrasive: Abrasive medium that is held within a bonding that erodes away to expose new abrasive medium as it is used.

2. Metal Bond Tooling: Diamond tooling that contains industrial grade diamonds with a metallic bonded matrix that is attached to rotating heads to refine the concrete substrate. These tools are available in levels of soft, medium, and hard metallic matrices that are matched with contrasting concrete substrates (i.e. hard matrix/soft concrete, medium matrix/medium concrete, soft matrix/hard concrete) and are typically used in the grinding and early honing stages of the polishing process.

3. Resin Bond Tooling: Diamond tooling that contains industrial grade diamonds within a resinous bonded matrix (poly-phenolic, ester-phenolic, thermoplastic-phenolic) that is attached to rotating heads to refine the concrete substrate. Resin bond tooling does not have the soft/medium/hard characteristics of metal bond tooling and are typically used for the later honing and polishing stages of the polishing process.

4. Hybrid Tooling: Diamond tooling that combines metal bond and resin bond that has the characteristics of both types of tooling. These types of tools are typically used as either transitional tooling from metal bond tools to resin bond tools or as a first cut tool on smooth concrete surfaces.

5. Transitional Tooling: Diamond tooling that is used to refine the scratch pattern of metal bond tooling prior to the application of resin bond tooling in an effort to extend the life of resin bond tooling and to create a better foundation for the polishing process.

6. Abrasive Pad: An abrasive pad, resembling a typical floor maintenance burnishing pad, that has the capability of refining the concrete surface on a microscopic level that may or may not contain industrial grade diamonds. These pads are typically used for the maintenance and/or restoration of previously installed polished concrete flooring.

E. Power Supply: Ensure appropriate power sources, generators, etc. as required to produce specified work and avoid disruption or delays on the project.

F. Dust Extraction: Provide dust extraction system, pre-separator, and squeegee attachments with minimum flow rating of 580 cubic feet per minute.

PART 3 EXECUTION

3.1 EXAMINATION

A. Compliance: Comply with manufacturer's instructions for installation of materials. Existing concrete must have a minimum compressive strength of 3000 psi and a minimum density of 100 pcf (pounds per cubic foot).

B. Coordinate installation with adjacent work to ensure proper sequencing of construction.

C. Protect adjacent and surrounding surfaces not specified to receive overlay with necessary means to ensure protection against overspray, water or other harmful debris.

D. Close off areas receiving overlay during installation from all traffic and stop excessive air movement across the top of the surface until overlay has reached final set.

E. Advise Contractor of discrepancies preventing proper installation of materials. Do not proceed with the work until unsatisfactory conditions are corrected.

3.2 VAPOR TESTING CONCRETE FLOORS

A. Alkalinity:

1. Test Method: Measure pH according to method indicated in ASTM F 710.

2. Acceptable Results: pH between 8 and 14.

B. Moisture Vapor Transmission Rate:

1. Test Method: Perform anhydrous calcium chloride test according to ASTM F 1869.

2. Acceptable Results: Up to 10 pounds per 1000 square feet in 24 hours when one coat of TXP Fast primer is used at a minimum 10 mils. When test results indicate over 10 pounds up to 20 pounds per 1000 square feet in 24 hours, use two coats of TXP Fast Primer as follows:

a. Apply two coats with the first coat applied neat at a minimum 16 mil thickness, followed by a second coat at a minimum of 10 mils with full broadcast aggregate to achieve a total minimum thickness of 25 mils.

C. Relative Humidity

1. Test Method: Perform relative humidity test using in situ probes according to ASTM F 2170.

2. Acceptable Results: Up to 100 percent.

D. When additional sealers, guards or coatings are used, the manufacturer’s MVT and RH recommendations must be followed.

3.3 PREPARATION

A. Mechanically roughen surfaces and remove all loose, unsound, contaminated material.

B. Use appropriate mechanical means and methods to completely remove existing floor coverings, coatings, mastics, paints, adhesives and other floor materials that may inhibit bond.

C. Bonding surfaces must be clean, sound, and free from any materials that may inhibit bond such as oil, dirt, asphalt, sealing compounds, acids, wax and loose dust and debris.

D. Prevent damage to substrate during demolition and preparation.

E. Correct conditions that are found to be out of compliance with the requirements of this section, to include substrate repair and pre-leveling, joint and crack treatment as required to achieve the specified finish.

F. Mechanically prepare the substrate to an ICRI CSP 3.

G. Where required, place divider/terrazzo strips. Level and set strips to appropriate heights prior to pouring the overlay.

H. Pin or otherwise mark all existing joint locations to ensure they can be located and re-saw cut after placement of topping.

I. Prime the prepared concrete in accordance with manufacturer's published procedures and recommendations.

J. Immediately broadcast washed and kiln dried angular cut #20 - #30 grit silica sand onto epoxy primer ensuring complete coverage prior to initial set. Broadcast to refusal.

K. After epoxy primer cures, remove all loose silica sand.

3.4 MIXING

A. Comply with manufacturer's printed instructions.

B. Include careful monitoring of mix water volume being used, with allowance for the following special designs.

1. Any decorative aggregates used and loading dosage as recommended and approved by the overlay manufacturer.

2. Integral colorants. Must be approved by the overlay manufacturer and water volume per mix verified.

C. Use CS Unitec (Hippo Mixer), batch mixers or equivalent to prepare overlay material. If barrel mixing, use a 1/2" heavy-duty drill (12 mm) with a minimum of 650 rpm.

D. Clean barrels/mixers periodically to remove any unmixed and/or hardened material prior to placing the mixed overlay onto the floor.

E. Verify proper flow using the Rapid Set Self Leveling Products Field Flow Test.

3.5 APPLICATION

A. Comply with manufacturer's printed instructions and the following:

1. Verify that all substrates and ambient temperatures are between 50°F (10°C) to 90°F (32°C) and will remain within range until the overlay has reached full cure. Ideal installation conditions are 60°F (15.6°C) to 80°F (26.7°C).

2. To prevent pinholing and micro-crazing, eliminate air movement over the surface and do not apply overlay when relative humidity is below 30%.

3. Have all required tools, equipment and materials organized and as close to the placement area as possible.

4. Pour or pump overlay and spread in place with a gauge rake set at the appropriate thickness. Use the Rapid Set TRU PC Spiked Roller to coax the material into place. Use rounded metal spiked shoes to avoid damaging the primer. Contact the CTS Cement Technical Support (800.929.3030) if other tools are required. Use methods that avoid pinholes.

5. Place overlay to grade levels required and to conform to drawing details.

6. The minimum installation thickness must be 3/8" minimum. For high-load, rubber wheeled traffic areas, nominal thickness must be 1/2" minimum.

B. Pre-Leveling: Use Rapid Set LevelFlor from featheredge to 1" (2.5 cm) thick and up to 5" (12.7 cm) thick when extended with aggregate. Mix and install according to manufacturer's

published instructions. Allow the pre-leveling course to dry at least 12 to 16 hours before application of primer and overlay.

3.6 CURING

A. For exterior applications, apply a fine water mist to newly hardened surface as soon as it can be done without marring the surface. Fine water mist continuously until one hour after final set.

B. Allow topping to cure for a minimum of four (4) hours prior to saw cutting joints.

C. Prevent damaged to overlay and protect from all traffic for the length of time recommended by the manufacturer.

3.7 JOINT CUTTING, PREPARATION AND FILLING

A. Joints must be installed prior to the polishing process.

B. Honor all existing joints. Locate original joint locations and saw cut through topping into the original joint. Saw blade must penetrate to the depth of the original joint or 2" deep, whichever is smaller. Prefill joints greater than 2" deep.

C. Ensure saw-cut joint is completely free of dust/debris/laitance.

D. Apply stain prevention film or other masking agent along surface on both sides of the joint to avoid residual staining.

E. Install joint filler. Fill from the bottom of the joint, being careful to avoid entrapping air.

F. Slightly overfill joint to a crowned profile.

G. After sufficient cure, razor excess filler leaving a filler profile that is flush with floor surface.

H. If filler profile is low/concave, remove top 1/2" of filler and re-apply.

3.8 POLISHING

A. Allow overlay to cure for a minimum of 24 hours before beginning the polishing process.

B. Use overlay manufacturer's approved polishing system from one of the following manufacturers:

1. HTC.

2. SASE.

3. Husqvarna.

4. Lavina.

5. STI.

C. Comply with overlay manufacturer's and polishing equipment manufacturer's published Technical Bulletins and guidelines.

3.9 SEALING

A. Apply densifiers, sealers, guards or stain protectors per manufacturers’ instructions.

B. Achieve waterproofing, hardening, dust-proofing, and abrasion resistance of the surface without changing the designed aesthetics of the finish.

3.10 PROTECTION

A. Prevent damaged to overlay and protect from all traffic for at least 72 hours after final surface treatment.

B. Do not allow standing water, rubber matting, or other non-breathable objects onto the polished surface.

C. Protect the finished surfaces from damage, soiling and other construction activities.

D. Provide suitable protective cover without damaging the polished surface.

E. Follow maintenance guidelines as provided in Section 1.4, "Submittals."

3.11 CLEAN-UP

A. Remove and legally dispose of debris material from job site.

B. Clean excess material from surrounding areas and all tools immediately, before material cures. If materials have cured, remove using mechanical methods that will not damage the substrate.

C. Clean adjacent surfaces as needed using materials and methods recommended by the manufacturer of the material being cleaned. Remove and replace work that cannot be cleaned to the satisfaction of the Project Designer/Owner.

END OF SECTION

SECTION 033543

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. Concrete work - Section 033000.

1.4 REFERENCES

A. United States Green Building Council (USGBC): Leadership in Energy and Environmental Design (LEED): Green Building Rating System for New Construction and Major Renovations (NC) Version 3.0 (2009), www.usgbc.org

B. American Concrete Institute (ACI): ACI 302.1R Guide for Concrete Floor and Slab Construction.

C. 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.

D. 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. Plan view of floor and joint pattern layout.

3. Areas to receive colored surface treatment.

4. Hardener, sealer, densifier in notes.

B. Samples: Submit 24" x 24" samples showing sheen and full chemical treatments, including colorant, for Architect's approval.

C. 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.

D. 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.

E. Warranty: Submit warranty documents specified.

F. 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, fly ash, 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.

6. Size of aggregate to be coordinated with desired finish per approved sample and mock-up.

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.

B. Provide product by WR Meadows or approved equal.

2.2 MATERIALS

A. Equipment to be used for grinding/polishing shall be:

1. Three-head counter rotating variable speed floor grinding machine.

2. Dust extraction system and pre-separator.

3. 75kw MQ power generator or equivalent.

B. Equipment to be used for grinding/polishing shall possess at least 775 lb. of head pressure.

C. Equipment to be used for edge grinding/polishing shall be a hand grinder with dust extraction equipment.

D. Diamond grinding segments shall be:

1. Metal bonds: 40, 60, 80 and 150 grit.

E. Resin bond grinding segments shall be:

1. Resin bonds: 100, 200, 400, 800, 1500, and 3000 grit.

F. Grinding pads for edges shall be:

1. Resin bonds: 40, 60, 80, 100, 200, 400, 800, 1500, and 3000 grit.

G. Equipment to be used for densifying and cleaning the floor after grinding/polishing procedure has been performed:

1. Tennant ride-on auto-scrubber or equivalent with a head pressure of 150 lb.

2. Follow auto-scrubber's manual for cleaning instructions after densifying and conditioning the floor.

3. Do not allow densifier to remain inside the auto-scrubber after densifying.

H. Concrete Densifier:

1. Liquid hardener/densifier shall be

a. LIQUI-HARD ULTRA by W. R. MEADOWS.

2. Concrete Enhancer:

a. Water-based, synthetic polymer concrete floor enhancer shall be BELLATRIX by W. R. MEADOWS.

2.3 RELATED MATERIALS

A. Water: Potable water.

Specification for polished concrete sealant to added. To be stain and slip resistant and at least semi-impregnating.

Samples to be provided for color confirmation.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive treatment. Notify architect if surfaces are not acceptable. Do not begin application until unacceptable conditions have been corrected.

B. Final polishing system installation shall be equivalent to that as accepted on the mock-up.

3.2 GENERAL POLISHING REQUIREMENTS

A. Coordinate polishing operations with other associated work and trades.

B. Do not use stain or scuff removing agents.

C. Begin and complete polishing within two weeks prior to possession date.

D. Utilize machines to the maximum extent practical to achieve optimum efficiency.

3.3 SURFACE PREPARATION

A. Protect adjacent surfaces not designated to receive treatment.

B. Clean and prepare surfaces to receive treatment in accordance with manufacturer's instructions, ensuring that all stains, oil, grease, form release agents, dust, and dirt are removed prior to application.

C. Ensure concrete is a minimum of 28 days old.

3.4 APPLICATION

A. To obtain satin finish, ensure installer follows the applicable procedures incorporating grinding plates in the following order.

1. Verify that the floor is clean and dry prior to polishing procedure.

2. Inspect and verify that the floor does not have curled joints, large cracks, spalling, or lippage. If lippage or curled joints are present, correct prior to commencement of the work of this Section.

3. Using the 80-grit metal bond grinding segment, grind the floor surface at a rate of 500 ft.2/hr. Vacuum the surface to remove loose particulates.

4. Using the 150-grit metal bond grinding segment, grind the floor surface at a rate of 600 ft.2/hr. Vacuum the surface to remove loose particulates.

5. Apply concrete densifier according to manufacturer’s instructions.

6. Squeegee off excess material.

7. Wait 24 hours.

8. Verify that the floor is dry and clear of debris prior to continuation of polishing procedure.

9. Using the 100-grit resin bond polishing segment, grind the floor surface at a rate of 600 ft.2/hr. If scratches from the previous grit are still apparent, decrease the rate of grinding by 100 ft.2 until scratches are removed. Vacuum the surface to remove loose particulates.

10. Using the 200-grit resin bond polishing segment, grind the floor surface at a rate of 700 ft.2/hr. If scratches from the previous grit are still apparent, decrease the rate of grinding by 100 ft.2 until scratches are removed. Vacuum the surface to remove loose particulates.

11. Using the 400-grit resin bond polishing segment, grind the floor surface at a rate of 700 ft.2/hr. If scratches from the previous grit are still apparent, decrease the rate of grinding by 100 ft.2 until scratches are removed. Vacuum the surface to remove loose particulates.

12. Using the 800-grit resin bond polishing segment, grind the floor surface at a rate of 1000 ft.2/hr. If scratches from the previous grit are still apparent, decrease the rate of grinding by 100 ft.2 until scratches are removed. Vacuum the surface to remove loose particulates.

13. Using the auto-scrubber, clean the floor thoroughly as per manufacturer's instructions with a white non-woven pad. Pads should be replaced approximately every 30,000 ft.2.

B. To obtain semi-gloss finish, ensure installer follows the applicable procedures incorporating grinding plates in the following order.

1. Verify that the floor is clean and dry prior to polishing procedure.

2. Inspect and verify that the floor does not have curled joints, large cracks, spalling, or lippage. If lippage or curled joints are present, correct prior to commencement of the work of this Section.

3. Using the 80-grit metal bond grinding segment, grind the floor surface at a rate of 500 ft.2/hr. Vacuum the surface to remove loose particulates.

4. Using the 150-grit metal bond grinding segment, grind the floor surface at a rate of 600 ft.2/hr. Vacuum the surface to remove loose particulates.

5. Apply concrete densifier according to manufacturer's instructions.

6. Squeegee off excess material.

7. Wait 24 hours.

8. Verify that the floor is dry and clear of debris prior to continuation of polishing procedure.

9. Using the 100-grit resin bond polishing segment, grind the floor surface at a rate of 600 ft.2/hr. If scratches from the previous grit are still apparent, decrease the rate of grinding by 100 ft.2 until scratches are removed. Vacuum the surface to remove loose particulates.

10. Using the 200-grit resin bond polishing segment, grind the floor surface at a rate of 700 ft.2/hr. If scratches from the previous grit are still apparent, decrease the rate of grinding by 100 ft.2 until scratches are removed. Vacuum the surface to remove loose particulates.

11. Using the 400-grit resin bond polishing segment, grind the floor surface at a rate of 700 ft.2/hr. If scratches from the previous grit are still apparent, decrease the rate of grinding by 100 ft.2 until scratches are removed. Vacuum the surface to remove loose particulates.

12. Using the 800-grit resin bond polishing segment, grind the floor surface at a rate of 1000 ft.2/hr. If scratches from the previous grit are still apparent, decrease the rate of grinding by 100 ft.2 until scratches are removed. Vacuum the surface to remove loose particulates.

13. Using the 1500-grit resin bond polishing segment, grind the floor surface at a rate of 1500 ft.2/hr. If scratches from the previous grit are still apparent, decrease the rate of

grinding by 100 ft.2 until scratches are removed. Vacuum the surface to remove loose particulates.

14. Using the auto-scrubber, clean the floor thoroughly as per manufacturer's instructions with a white non-woven pad. Pads should be replaced approximately every 30,000 ft.2.

C. To obtain high-gloss finish, ensure applicator follows the applicable procedures incorporating grinding plates in the following order.

1. Verify that the floor is clean and dry prior to polishing procedure.

2. Inspect and verify that the floor does not have curled joints, large cracks, spalling, or lippage. If lippage or curled joints are present, correct prior to commencement of the work of this Section.

3. Using the 80-grit metal bond grinding segment, grind the floor surface at a rate of 500 ft.2/hr. Vacuum the surface to remove loose particulates.

4. Using the 150-grit metal bond grinding segment, grind the floor surface at a rate of 600 ft.2/hr. Vacuum the surface to remove loose particulates.

5. Apply concrete densifier according to manufacturer's instructions.

6. Squeegee off excess material.

7. Wait 24 hours.

8. Verify that the floor is dry and clear of debris prior to continuation of polishing procedure.

9. Using the 100-grit resin bond polishing segment, grind the floor surface at a rate of 600 ft.2/hr. If scratches from the previous grit are still apparent, decrease the rate of grinding by 100 ft.2 until scratches are removed. Vacuum the surface to remove loose particulates.

10. Using the 200-grit resin bond polishing segment, grind the floor surface at a rate of 700 ft.2/hr. If scratches from the previous grit are still apparent, decrease the rate of grinding by 100 ft.2 until scratches are removed. Vacuum the surface to remove loose particulates.

11. Using the 400-grit resin bond polishing segment, grind the floor surface at a rate of 700 ft.2/hr. If scratches from the previous grit are still apparent, decrease the rate of grinding by 100 ft.2 until scratches are removed. Vacuum the surface to remove loose particulates.

12. Using the 800-grit resin bond polishing segment, grind the floor surface at a rate of 1000 ft.2/hr. If scratches from the previous grit are still apparent, decrease the rate of grinding by 100 ft.2 until scratches are removed. Vacuum the surface to remove loose particulates.

13. Using the 1500-grit resin bond polishing segment, grind the floor surface at a rate of 1500 ft.2/hr. If scratches from the previous grit are still apparent, decrease the rate of grinding by 100 ft.2 until scratches are removed. Vacuum the surface to remove loose particulates.

14. Using the 3000-grit resin bond polishing segment, grind the floor surface at a rate of 2000 ft.2/hr. If scratches from the previous grit are still apparent, decrease the rate of grinding by 100 ft.2 until scratches are removed. Vacuum the surface to remove loose particulates.

15. Using the auto-scrubber, clean the floor thoroughly as per the manufacturer's instructions with a white non-woven pad. Pads should be replaced approximately every 30,000 ft.2.

3.5 CONCRETE ENHANCER

A. Allow 24 hours before proceeding with concrete enhancer application.

B. Spray concrete enhancer full strength from container using an industrial sprayer delivering 1/10th of a gallon per minute.

C. Pre-wet micro-fiber applicator with concrete enhancer prior to use.

D. Uniformly spread concrete enhancer with a micro-fiber applicator creating a monolithic, thin, even film, ensuring that the product is not allowed to dry before spreading is complete.

E. Do not over apply concrete enhancer.

F. For optimum performance, apply a second coat at a 90° (right) angle to the first coat, after the first coat is thoroughly dry.

G. Allow 24 hours for concrete enhancer to dry.

H. Burnish with a hog's hair pad at 2000 rpm or substitute a diamond pad if necessary.

3.6 FIELD QUALITY CONTROL

A. Review procedures with installer to correct unacceptable areas of completed polished concrete floor system.

B. Test interior floor for slip resistance in accordance with ASTM D2047.

C. Test Results: Test results will be provided in writing to Owner and Contractor within 24 hours after tests are completed.

3.7 ADJUSTMENTS

A. Polish to higher gloss those areas not meeting specified gloss levels per mock-up.

B. Fill joints flush to surface.

3.8 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.

3.9 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

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:

1. Structural steel.
2. Bolts, washers, and other steel accessories
3. Welded steel connections.
4. Grout.
5. Field-installed shear connectors

B. Related Sections:

1. Cast-in-Place Concrete – Section 033000
2. Steel Joist Framing – Section 052100
3. Steel Decking – Section 053100

1.3 DEFINITIONS

A. Structural Steel: Elements of structural-steel frame, as classified by American Institute of Steel Construction (AISC) 303, "Code of Standard Practice for Steel Buildings and Bridges."

B. Heavy Sections: Rolled and built-up sections as follows and subjected to special notch toughness, fabrication, welding and inspection requirements as defined in this specification:

1. Shapes included in ASTM A6 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.

1.4 ACTION SUBMITTALS

A. General:

1. Review of submittals if of a general nature only, and responsibility for conformance with the intent of the Contract Documents shall remain with the Contractor. Review does not imply nor state that fabricator has correctly interpreted the Contract Drawings.

2. All submissions shall be in accordance with the submission schedule developed and agreed between the Architect and Contractor at the commencement of the project. Submission shall include dates of order and delivery of materials to the shop and the site.

3. Shop drawing schedule shall allow adequate time for reviews. Submittal shall include all related pieces in an assembled or area. The Contractor shall allow adequate time in shop drawing preparation stage for the dimensioning process and coordination with the Architectural Drawings and those of other disciplines. Submit a schedule for steel shop and erection drawings.

B. Product Data: For each type of product indicated.

C. Shop Drawings: Show fabrication of structural-steel components, including anchor rod setting plans, details of layout and connections, fabrication of all members, and element and erection plans. Direct copies of the Contract Documents are not acceptable as a submission from the Contractor.

1. Submit shop drawings to Architect for review and obtain Architect's acceptance prior to start of fabrication. Where shop drawings are resubmitted, the Contractor shall cloud and identify all changes made due to additions, deletions, and corrections to the shop drawing. Shop drawings resubmitted without each change being clouded and identified will be returned for resubmission.

2. Only shop drawings marked "No Exceptions Taken" or "Make Corrections Noted, Resubmittal Not Required" may be used by the Contractor in the work. Shop drawings marked "Rejected" or "Revise and Resubmit, Not Accepted for Reasons Given" shall be corrected and completed as required and resubmitted and approved before they are used in the work.

3. Include layout, member size, and weights, materials used, and beam marks as well as orientation and relation of members to appropriate grid lines and setting elevations for column bases. Reference shop drawings to specific location and detail number on the Structural Drawings.

4. Include details of cuts, connections, splices, camber, holes, openings, doubler plates, stiffeners and other pertinent data, including bolt hole sizes, connection materials, and welded joint designations.

5. Include embedment drawings.

6. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.

7. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pre-tensioned and slip-critical high-strength bolted connections.

8. Indicate surface preparation and finishes.

9. Submit plans of all levels locating the edge of slab at perimeter and at interior openings.

10. Where items such as anchor bolts and inserts are scheduled to be set into concrete or masonry provide setting drawings, templates, instructions and directions for their installation. Coordinate delivery with other work to avoid delay of job progress.

D. Connection Design:

1. The Contractor is responsible for the design of connections when they are not fully defined on the Contract Documents.

2. The Engineer shall be licensed in the state of New York. At the commencement of the project submit a letter signed and sealed by the Engineer that will supervise the steel connection design attesting to this responsibility.

3. At the end of the steel shop drawing submission phase submit a letter, signed and sealed by the Engineer supervising the steel connection design, attesting to the completion of the work.

4. Submit calculations of all connections. Calculations and details shall be clearly keyed to the appropriate members on the construction documents. Calculations shall bear the seal of the Engineer supervising design of the steel connections.

5. When connection calculations are resubmitted, the Contractor shall cloud and identify all changes made due to additions, deletions, and corrections to the calculation. Calculations will be returned for resubmission if changes are not identified.

6. Contractor shall not proceed with steel erection until these requirements are fulfilled.

7. The Contractor shall not submit any piece drawing for review until all connections used on that drawing have been reviewed by the Engineer. Drawings submitted with connections that have not previously been submitted for review will be rejected as incomplete.

E. LEED Submittals: Refer to Section 018113.14 “Sustainable Design Requirements” for submittal requirements where LEED is being pursued for building.

F. Erection Procedures:

1. Submit procedures, methods, sequences of erection, temporary shoring and guying, and equipment proposed for erecting structural steel. Erection procedures are submitted for record only and therefore will not be returned to the Contractor.

G. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1, "Structural Welding Code - Steel," for each welded joint qualified by testing, including items listed below. All submitted Procedures shall be reviewed by the Testing Agency prior to use on the project for conformance with the requirements of AWS D1.1. The Procedures will be submitted to the Engineer for record only.

1. Power source (constant current or constant voltage).

2. Electrode and flux manufacturer and trade name.

3. Tolerances or the acceptable range of values, applicable to the various welding parameters.

4. Where backgouging is required provide back gouging criteria (e.g. smoothness, grinding, gouge shape, inspection by the welder, etc.).

5. For multi-pass welds define sequence and layering of passes.

6. Welding Procedure Qualification Record (WPQR) Tests: For WPSs that are not pre-qualified per AWS D1.1, submit the supporting WPQR tests results conducted in accordance with AWS D1.1 along with the corresponding WPS.

7. When the required effective throat thickness of flare groove welds is larger than allowed by Table J2.2 of AISC “Steel Construction Manual”, submit data establishing by qualification the consistent production of such larger effective throat thickness. Qualification of effective throat thickness shall be as required by the AISC specification.

8. For complete penetration butt or groove welds, include test records for the following only at locations specified on the drawings: toughness, (Charpy tests for weld metal), heat affected zone.

9. In addition to the WPS submit fabrication and erection procedures where needed to control shrinkage, fabrication tolerances, or to insure proper inspection.

H. Fastener Installation Procedures: Submit written procedures for the pre-installation testing, installation snugging, pre-tensioning, and post-installation inspection of fasteners. The procedures shall meet all requirements of the Research Council on Structural Connections (RCSC) "Specification for Structural Joints Using ASTM A325 or A490 Bolts" and the Contract Documents.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer and fabricator.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

D. Mill test reports for structural steel, including chemical and physical properties, regardless of thickness or use. Reports shall comply with ASTM A6.

1. Submit a mill report for each heat of steel used, and certified fastener reports for all fasteners, including nuts, washers and direct tension indicators prior to the start of fabrication. For unsatisfactory mill test report, retest steel.

2. Include Charpy test results for heavy sections and for materials where Charpy values are specified. Testing required per AISC Section A3.1c for sections with over 2” flanges with net tension and have CJP welds.

3. Mill test reports shall include ladle analysis and tensile elongation and bend tests.

4. Mill reports shall be traceable to individual pieces of steel used.

E. Product Test Reports and Certifications: Submit manufacturer's test reports and certifications as listed below. Test Reports and Certifications are submitted for record only and therefore will not be returned to the Contractor. A copy of the test reports and certifications shall be sent to the owner's Quality Assurance Agency. The Contractor Certificate of Compliance letter shall accompany the Manufacturer's Certifications.

1. Bolts, nuts, and washers including mechanical properties and chemical analysis. Certifications for high strength bolts shall conform to certification requirements contained in ASTM A325, A490, F1852, F959, F2280.

2. Direct-tension indicators.

3. Tension-control, high-strength bolt-nut-washer assemblies.

4. Shop primers.

5. Nonshrink grout.

6. Welding electrodes, fluxes and shielded gas products. Certifications shall satisfy the applicable AWS A5 and project requirements.

7. Spray-on fireproofing. Submit certificate issued by paint manufacturer ensuring compatibility between the primer and the spray-on fireproofing.

F. Source quality-control reports.

G. Field quality control reports

H. Survey of existing conditions

I. Submit fabricators identification mark system to Testing Agency prior to fabrication.

J. As-Built Drawings: At the end of the work included in this Section submit a complete set of reproducible drawings incorporating all changes, additions and deletions to the Construction Drawings due to revisions, change orders, field conditions, or any other reason.

1.6 QUALITY ASSURANCE

A. Testing Agency: Shop and field testing and inspection of steelwork specified in this document or requested by the Owner will be performed by an independent agency engaged by the Owner.

1. The Testing Agency shall be furnished with the following:

a. One complete set of fabrication and erection drawings.

b. Material bills, cutting lists, order sheets and mill test reports.

c. Information regarding time, place of rolling and shipment of materials to shop.

d. If requested, representative sample pieces for testing.

e. Full and ample means and assistance for testing materials.

f. Access and facilities, including scaffolding, temporary work platforms, etc., for testing and inspection at all places where materials or components are stored, fabricated or erected in the mill, shop or field.

g. Complete set of welding procedures.

h. Welder qualifications.

i. AISC fabricator certification documents, QA/QC manual and most recent AISC audit.

j. Reports for all Contractor tests and inspections.

2. In addition to the work specified elsewhere in the Contract Documents, the Testing Agency shall review the following for compliance with project specifications:

a. Fastener Installation Procedures.

b. WPSs and WPQRs.

c. Manufacturer's Test Reports and Certifications .

d. Welder qualification.

B. Comply with applicable provisions of the current edition of the following specifications and documents, except where more stringent requirements are shown or specified:

1. AISC 303 "Code of Standard Practice for Structural Steel Buildings and Bridges".

2. AISC 360, "Specification for Structural Steel Buildings".

3. AISC "Steel Construction Manual".

4. RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts." with supplements.

5. American Welding Society (AWS) D1.1.

6. New York State Building Code, current edition.

C. All work shall be performed by qualified operators experienced in their field of work and as otherwise required by these specifications.

D. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.

E. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category ACSE.

F. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement P1 or SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."

G. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1 for each process, position and joint configuration. Each operator shall have been qualified as prescribed by AWS and shall be approved by the New York State building department. Qualification performed more than six months prior to the start of the welding by the welder is acceptable, provided written documentation is submitted showing that the welder has continued to use the applicable welding process on an ongoing basis since the test was conducted, with no lapse in service exceeding six months.

1. Welder Certificates shall be submitted to Testing Agency prior to welding.

2. Require welders to retake the qualification test if, as determined by the Architect or Testing Agency, there is a reasonable doubt as to the proficiency of the welder. If the welder does not requalify, he shall not perform any welding on the project.

3. In addition to AWS D1.1 requirements on welder Qualification, qualify welders making welds with restricted access (such as welding the bottom flanges of girders to column flanges through cope or access holes in the girder webs) by using a mock-up assembly identical to the actual conditions of producing weldments in the field, using the approved WPS.

4. Welder qualification shall include passing the bend test and Charpy tests when Charpy values are specified for the electrode.

H. Contractor's Quality Control Plan: Quality Control includes the functions performed by the Contractor to ensure that the material and workmanship of structural steel construction meets the project specifications and applicable standards. The Contractor shall submit a Quality Control Plan that addresses all inspection issues, including fabrication/erection testing and inspection per AWS D1.1. The verification testing and inspection carried out by the Testing Agency does not relieve the contractor of the responsibility for conducting their own quality control/inspection program to ensure the requirements of the Contract Documents have been met. The Contractor's Quality Control Plan will be reviewed by the Testing Agency.

I. Quality Control Inspector Qualifications: Along with Quality Control Plan, Contractor shall submit written qualifications for all inspectors to be assigned Quality Control functions for structural steel work, including general inspection, bolting inspection, welding inspection, and non-destructive testing. Qualifications for welding inspectors shall show evidence of ability to monitor all WPS variables, check weld sizes, and visually detect weld defects.

J. Unidentifiable Materials: Materials delivered with certificates are classified as identifiable; those without certificates are classified as unidentifiable.

1. Testing of Unidentifiable Material: By Contractor's testing agency; paid for by Contractor.

a. General: Test material not identifiable by heat number and mill test or other acceptable manufacturer's identification per ASTM A370 as follows.

b. Structural Shapes and Plates: From coupons taken from material; one tensile test and one bend test per 5 tons of each shape.

c. High Strength Bolts: Each lot of 100 bolts; tensile tests on 2 bolts in full size and one tensile test on a 1/2" diameter machined specimen.

d. Other Materials: Test as directed.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Do not handle structural steelwork until paint has thoroughly dried. Care shall be exercised to avoid abrasions and other damage.

B. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration. Material shall be kept free from dirt, grease, and other foreign matter.

1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed, to the acceptance of the Architect, and at no additional cost to the Owner. Materials showing evidence of damage will be rejected and shall be immediately removed from the site.

C. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.

1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.

2. Clean and re-lubricate bolts and nuts that become dry or rusty before use.

3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F1852 fasteners and for retesting fasteners after lubrication.

D. Requirements for storage and handling of electrodes shall be per AWS D1.1. Additional requirements include:

1. Long term storage of weld consumables shall be indoors, where moisture or dew does not collect, and in undamaged manufacturer’s shipping bags, boxes, and containers.

2. Open Flux Cored Arc Welding (FCAW) electrodes shall be completely covered during hours of non-use (i.e., weekends, nights of nonuse, days of nonuse, etc.). Where rain or dew could be expected to collect (i.e., open floors of erection site, open shop bays, etc.), electrodes shall also be covered.

1.8 COORDINATION

A. Surveys: Contractor shall conduct field surveys and field verification as required to incorporate existing conditions from previous works, such as foundations and existing buildings, to the work before shop drawings are produced.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, templates, instructions, and directions for installation.

C. Notify the Owner’s Representative in sufficient time prior to shop or field fabrication or erection to permit testing and inspection without delaying work.

1.9 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site. Prior to performing fabrication or erection work, there shall be a pre-fabrication and pre-erection meeting to review welding procedures, bolting procedures, and inspection requirements for all welding and bolting operations. The meeting shall include the following individuals: Owner's Representative, Special Inspector, Steel Fabricator, Erector personnel supervising the shop, field and quality control work.

PART 2 PRODUCTS

2.1 STRUCTURAL STEEL MATERIALS

A. W-Shapes: ASTM A992

B. Channels, Angles: ASTM A572, Grade 50

C. Plate and Bar: ASTM A572, Grade 50

D. Cold-Formed Hollow Structural Sections: ASTM A500, Grade C structural tubing.

E. Steel Pipe: ASTM A53, Type E or S, Grade B.

1. Weight Class: As noted on Drawings.

2. Finish: Black except where indicated to be galvanized.

F. Heavy Sections: Heavy sections as defined in this specification shall have toughness properties meeting a Charpy V-Notch (CVN) value of 20 ft-lb at 70 degrees F. Testing shall be conducted in accordance with the current AISC specification.

G. Metallic Filler: Provide Plastic Steel Putty manufactured by Devcon Corporation where noted on drawings.

2.2 WELDING MATERIALS

A. Welding Material: Filler metal requirements shall conform to AWS D1.1 and AISC "Specification for Structural Steel Buildings". Minimum classified tensile strength of 70 ksi (E70). Use low hydrogen electrodes as defined by AWS D1.1, unless noted otherwise. For all CJP welds used on Heavy Structural Sections that are not part of the Seismic Load Resisting System the filler metal shall have a Charpy V-Notch (CVN) toughness of at least 20 ft-lb at 70 degrees F.

2.3 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A325, Type 1, heavy-hex steel structural bolts unless noted otherwise; ASTM A563, Grade C, heavy-hex carbon-steel nuts; and ASTM F436, Type 1, hardened carbon-steel washers; all with plain finish. ASTM F1852 Twist-Off Type Torque Control Bolts are a suitable alternative to ASTM A325 bolts, although use of such bolts shall not negate the requirement that Direct Tension Indicators be used for inspection.

1. Direct-Tension Indicators: ASTM F959, Type 325, compressible-washer type with plain finish. Use where noted 'slip-critical' or 'fully pre-tensioned' on Structural Drawings or

where ‘slip-critical’ or ‘fully pre-tensioned’ joint types are required by RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts".

B. High-Strength Bolts, Nuts, and Washers: ASTM A490, Type 1, heavy-hex steel structural bolts, where noted on drawings; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436, Type 1, hardened carbon-steel washers with plain finish. ASTM F2280 Twist-Off Type Torque Control Bolts are a suitable alternative to ASTM A490 bolts, although use of such bolts shall not negate the requirement that Direct Tension Indicators be used for inspection.

1. Direct-Tension Indicators: ASTM F959, Type 490, compressible-washer type with plain finish. Use where noted ‘slip-critical’ or ‘fully pre-tensioned’ on Structural Drawings or where ‘slip-critical’ or ‘fully pre-tensioned’ joint types are required by RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts".

C. Zinc-Coated High-Strength Bolts, Nuts, and Washers: ASTM A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH heavy-hex carbon-steel nuts; and ASTM F436, Type 1, hardened carbon-steel washers.

1. Finish: Hot-dip zinc coating.

2. Direct-Tension Indicators: ASTM F959, Type 325, compressible-washer type with mechanically deposited zinc coating finish.

D. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1heavy-hex head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.

1. Finish: Plain

E. Unfinished Bolts and Nuts (Machine Bolts) and Threaded Rods: ASTM A307, Grade A, low carbon steel bolts and nuts; ASTM F436, Type 1, hardened carbon-steel washers.

F. Unheaded Anchor Rods: ASTM F1554, Grade 36.

1. Configuration: Straight.

2. Nuts: ASTM A563 heavy-hex carbon steel.

3. Plate Washers: ASTM A36 carbon steel.

4. Washers: ASTM F436, Type 1, hardened carbon steel.

5. Finish: Plain.

G. Headed Anchor Rods: ASTM F1554, Grade 36, straight.

1. Nuts: ASTM A563 heavy- hex carbon steel.

2. Plate Washers: ASTM A36 carbon steel.

3. Washers: ASTM F436, Type 1, hardened carbon steel.

4. Finish: Plain.

H. Threaded Rods: ASTM A 36

1. Nuts: ASTM A563 heavy-hex carbon steel.

2. Washers: ASTM F436, Type 1, hardened carbon steel.

3. Finish: Plain.

I. Tie Rods: ASTM A36.

1. Nuts: ASTM A563 heavy-hex carbon steel.

2. Washers: ASTM F436, Type 1, hardened carbon steel.

3. Finish: Plain.

J. Eye Bolts and Nuts: Made from cold-finished carbon steel bars, ASTM A108, Grade 1030.

K. Sleeve Nuts: Made from cold-finished carbon steel bars, ASTM A108, Grade 1018. Minimum proof load of sleeve nuts shall be such that when loaded axially the sleeve nut shall be stronger than the ultimate capacity of the connected parts.

2.4 PRIMER

A. Comply with Division 09 Section “Painting and Finishing”.

B. Primer Paint shall comply with all applicable SSPC requirements and shall be compatible with finish paints and spray-on fireproofing specified elsewhere.

C. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20.

D. Primer:

1. Typical Interior Primer: SSPC-Paint 25, Type II. Primer shall comply with the requirements called out in the “Green Seal Standard for Anti-Corrosive Paints” (GC-03).

2. Typical Exterior Primer: SSPC-Paint 20, Type II, Organic.

2.5 GROUT

A. Grout shall have a minimum 2400 psi compressive strength in 48 hours and 6000 psi compressive strength at 28 days.

B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.6 CONNECTION DESIGN

A. Contractor shall design all steel connections not fully defined in the Contract Documents. Design shall be performed by a qualified professional engineer licensed in the State of New York.

B. Type of Connections

1. All connections shall be one of the following:

    a. High-strength bolts assemblies.

    b. Unfinished bolts assemblies.

    c. Welds.

2. When the type of connection is shown on the Drawings use that type of connection unless otherwise approved in writing by the Engineer of Record.

3. Use a connection other than unfinished bolts where required by code and in the following locations:

    a. All beam and column connections and splices unless otherwise noted on Drawings.

    b. All connections indicated as such.

    c. Connections that are a part of the lateral force resisting system.

    d. Connections for supports of running machinery or of other live loads which produce impact.

    e. Connections carrying cooling tower loads.

    f. Beams supporting columns or posts.

    g. Connections for cantilevers.

    h. Full and partial moment connections.

C. Design Criteria.

1. Design connections for the loads and according to the requirements in the Contract Documents and the applicable building regulations.

2. Bolts shall be at least ¾ inches in diameter unless otherwise noted on Drawings.

2.7 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC 303 and AISC 360.

1. Camber structural-steel members where indicated. Fabricate beams and girders with natural camber upward, unless noted otherwise on the drawings. Camber stated in the drawings is the required camber after erection.

2. Fabricate beams with rolling camber up.

3. Identify high-strength structural steel according to ASTM A6 and maintain markings until structural steel has been erected.

4. Mark and match-mark materials for field assembly. Members shall be fabricated for delivery in a sequence that will expedite erection and minimize field handling of structural steel.

5. Splice members only where indicated on Structural Drawings or where accepted by the Architect.

6. All hollow members exposed to weather shall be sealed with continuous welds, incorporating structural welds where shown or required, or provide weep holes where water may accumulate.

7. Grind burrs, sharp arrises and ragged edges that would prevent solid seating of the connected parts.

8. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Tolerances:

1. Except as noted as follows, maintain fabrication tolerances of structural steel within the tolerances specified on the drawings and AISC's "Code of Standard Practice for Steel Buildings and Bridges."

C. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible. An unguided torch may be used provided the cut is within 1/8 inch of the required line.

1. Plane thermally cut edges to comply with requirements in AWS D1.1.

D. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

1. Use standard holes unless otherwise indicated as oversized, short-slotted, or long-slotted on the Drawings. Holes shall be drilled or punched at right angles to the surface of the metal. Making or enlarging holes by burning is prohibited.

2. Flame cut holes for fasteners are not acceptable.

3. Holes in column baseplates shall be within the limits of table 14-2 of AISC “Steel Construction Manual”

4. For the following conditions holes shall be drilled (not punched), even where punching is allowed by referenced standards: a) material having a thickness in excess of 7/8 inch or the hole diameter; b) column base plates; c) holes less than 6-inches from an edge that requires a CJP weld; d) where holes are subjected to welding shrinkage stresses.

E. Bending Steel Plate:

1. Bend plates perpendicular to the rolling direction.

2. Grind flame cut plate edges transverse to the bend line.

3. Grind out nicks in plate edges transverse to the bend line.

4. Round sharp corners on plate edges transverse to the bend line.

F. Heat Straightening: Will be permissible by the use of properly controlled heat, skilled personnel, proper equipment and in accordance with documents prepared by the fabricator and accepted. Reject materials that contain kinks or sharp angles. Material straightened prior to fabrication shall be rejected where it shows signs of distress or defects.

G. Planing and Milling: Accurately finish ends of columns and other members transmitting bearing loads. Mill bearing surfaces to true planes. Mill ends of columns perpendicular to centerline axis connection mid-depth points at ends of member. Cut and fit column and bearing stiffeners in manner to provide bearing over entire cross section

1. Column Base Plates

a. From 2" Through 4" Thickness: Straighten by pressing.

b. Over 4" Thickness: Plane top for column bearing; plane bottom when bearing on steel.

H. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 1, "Solvent Cleaning" and SSPC-SP 2, "Hand Tool Cleaning."

I. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.

1. Provide holes, slots and openings together with necessary reinforcing as shown on the Drawings required for securing work of other trades to the work specified here. Where openings are shown on the Drawings no change shall be permitted without prior approval. Openings shall be done in the shop.

2. Cut, drill, or punch holes perpendicular to steel surfaces.

3. Baseplate Holes: Cut, drill, or punch holes perpendicular to steel surfaces.

4. Weld threaded nuts to framing and other specialty items indicated to receive other work.

J. The Contractor shall cooperate fully with requests form inspection and testing personnel for access to the connections and joints to be inspected and tested. This includes beam and column turning in shop, weld backing removal when nondestructive examination indicates rejectable conditions, and access to platforms or scaffolding as required to perform the work safely.

K. Any technique not covered by this Section shall be submitted to the Engineer of Record for approval.

2.8 SHOP CONNECTIONS

A. General Bolting:

1. Product containers must be marked with lot numbers and traceability information so that correspondence with mill reports can be established. Manufacturer’s symbol and grade markings shall appear on all bolts, nuts, through-hardened washers and direct tension indicators.

2. Bolts shall be of a length that will extend to a point at least flush with the surface of the nuts, though not more than a length equal to the height of the nut, beyond the nuts unless otherwise noted.

3. Bolts shall be installed with threads excluded from the shear plane.

4. Washers shall be used on all bolts. Use beveled washers where bolts bear on sloping surface.

5. Circular and slotted holes shall be as per Specification for Structural Joints Using ASTM A325 or A490 Bolts.

6. Where bolt holes are subject to welding shrinkage stresses the holes shall be drilled.

B. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts" for type of bolt and type of joint specified. Contact surfaces of bolted parts shall as a minimum comply with the Class A requirements.

1. Joint Type shall be as noted on drawings.

2. Direct tension indicator (load indicating washers or "Tension-Set" bolts) method shall be used at slip-critical connections. "Turn-of-Nut" methods are not an acceptable alternative.

3. When connection has bolts and welds, fully tighten bolts prior to welding with the exception that in moment connections the flange welds shall be completed prior to final tightening of high strength bolts.

4. When already tensioned bolts have had their tension relaxed, replace the bolt and tension indicator and re-tighten.

C. Unfinished Bolts (Machine Bolts): Machine bolts shall be brought to a snug tight condition. Mutilate bolt threads for unfinished bolts to prevent the nuts from backing off.

D. Weld Connections: Comply with AWS D1.1 for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Shop welds shall be inspected in the shop before the work is painted or shipped.

2. Weld sizes where shown shall be assumed to be effective weld sizes.

3. All groove or butt welds shall be full penetration unless noted otherwise on the Drawings.

4. Where structural steel members are to remain exposed in the finished work, welds exposed to view shall be uniformly made and ground smooth.

5. Weld tabs shall be in accordance with AWS D1.1. In addition, weld tabs shall extend beyond the edge of the joint a distance equal to the plate thickness but not less than 1-inch except at access holes in beam/girder webs and at continuity plate clips. Weld tabs shall be oriented parallel to the joint preparation and to the weld direction. Weld dams are not allowed.

6. Remove weld tabs and backup plates and grind surfaces smooth as required for inspection or testing. Where tabs or backup bars interfere with architectural treatment or are exposed to view in the final structure, remove and grind smooth. Backup bars and run-off tabs at Heavy Structural Sections shall be removed.

7. Splices of members in tension, all members of moment frames and all members of braced frames that are made from heavy steel sections shall be made in conformance with Section J1.5 of AISC 360.

8. Weld variables shall be consistent with the recommendations of the electrode manufacturer.

9. Do not weld into column flange-to-web intersection as defined the AISC “k” and “k1” distances except for the doubler plate to column welds. Continuity plate welds shall stay clear of this area as noted on the drawings.

10. Sequence the work as necessary to accommodate testing.

11. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

12. Welding Procedures:

    a. Weld only in accordance with the Welding Procedure Specifications. WPS shall be readily available to all welders, inspectors, and supervisors during the production process.

    b. Consider toughness and notch sensitivity of steel in formation of the welding procedures to prevent brittle and premature fracture during fabrication and erection. Toughness requirements are to match those of the parent metal.

    c. Weld in a manner to minimize accumulation and concentration of through-thickness strains due to weld shrinkage. Sequence welds in a manner to reduce residual stresses (caused by welding) to a minimum value. Welding procedures shall incorporate measures necessary to eliminate cracking.

    d. Do not mix different electrodes in the same weld joint unless the interactions have been shown not to cause problems.

    e. Stringer passes only, no weaving or wash passes. Manipulation of the electrode for vertical welds (oscillation) shall be kept to a maximum movement of 4 to 5 electrode diameters.

    f. Welding shall not begin until joint elements are bolted or tacked in intimate contact and adjusted to dimensions shown in the Drawings, with proper allowance for any weld shrinkage.

    g. All tack welds shall be of the same quality as final welds. Preheat of tack welds is only necessary at the immediate area where the tack is placed. Preheat temperature is the same as for welding. Tack welds must be placed where they will be consumed in the weld, or be ground out to a depth of 1/8” but not rewelded

unless the gouge is greater than 1/8". If rewelding is necessary, it shall then be considered a new weld with all relevant weld inspections.

13. Refer to the Structural Drawings for additional requirements.

2.9 SHOP PRIMING

A. Shop prime all steel surfaces exposed to weather, or not completely concealed by interior finishes, unless noted otherwise and excepting the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.

2. Surfaces to be field welded and areas within 4 inches on each side of field welds.

3. Top surfaces of beams to receive metal deck.

4. Surfaces to be high-strength bolted except surfaces painted with Type B Primer. Areas with high-strength bolts exposed to the weather shall receive a primer coat compatible with slip-critical type connections.

5. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).

6. Galvanized surfaces.

7. Machined surfaces.

B. Steel members not otherwise painted shall be painted when subjected to condensation from piping, are in shower or steam rooms, are exposed to chemical fumes or are exposed to other conditions of potentially aggressive corrosion

C. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the specification required by the manufacturer of the paint system, and as a minimum all surfaces must be prepared as follows:

1. SSPC-SP1 "Solvent Cleaning"

D. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 2 mils for interior primer and 3 mils for exterior primer. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

3. Refer to 099000 "Painting and Finishing" for color requirements.

E. Painting: Prepare steel and apply a one-coat, nonasphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 2 mils. Surface preparation and

application shall be in accordance with SSPC-PS 12.01 “One-Coast Zinc-Rich Painting System”.

F. All steel exposed to the weather in the final structure shall be galvanized or painted.

G. The following surfaces shall be temporarily protected by a thin coating of varnish or lacquer:

1. Unpainted area around field welds.

2. Steel around high-strength bolts.

3. Machined surfaces.

H. Use special care if steel is fabricated, cleaned, and painted in damp weather to remove moisture from mill scale cracks.

2.10 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A123 and to bolts, nuts, and washers according to ASTM A153. Galvanize all items noted on Drawings to be galvanized and fasteners that connect galvanized components, except that ASTM A490 bolts shall not be hot-dip galvanized.

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.

2. Roughen faying surfaces of slip-critical high-strength bolted connections to achieve Class C surface accordance with the RCSC Specifications.

3. All steel to be galvanized shall be detailed to reduce the risk of liquid metal assisted cracking during the galvanizing process.

4. All galvanized steel shall be inspected after galvanizing for evidence of cracking or distortion caused by the galvanizing process.

2.11 SOURCE QUALITY CONTROL

A. Testing Agency: Testing Agency to perform shop tests and inspections as defined by AWS, AISC and these specifications. Testing Agency shall summarize their finding in inspection and testing reports. Reports shall identify any findings that are not in compliance with requirements of the project specifications.

1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

B. See Part 1 of this specification for additional testing and inspection requirements. As a minimum the inspector will make all tests and inspections as required by the Special Inspection provisions of the New York State Building Code, latest edition. Testing Agency will make all the tests and inspections indicated in the Contract Documents.

C. Contractor shall correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

1. Owner's Representative reserves right, at any time before final acceptance, to reject material not complying with requirements.

2. Any tests that may be necessary to reconfirm any noncompliance of original work, and as may be necessary to show compliance of corrected work, shall be at Contractor's expense.

D. 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.

E. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts."

1. High Strength Bolted Connections: High strength bolts specified as Snug-Tight (ST) need not be inspected for bolt tension.

2. High Strength Bolted Connections: For bolts specified as Pre-Tensioned or Slip-Critical, the special inspector shall observe the preinstallation testing and calibration procedures when such procedures are required by the installation method or by project plans or specifications; determine that all plies of connected materials have been drawn together and properly snugged and monitor the installation of bolts to verify that the selected procedure for installation is properly used to tighten bolts.

a. Periodic monitoring: Monitoring of bolt installation for pretensioning is permitted to be performed on a periodic basis (10% or a minimum of 2 bolts per connection) when using the turn-of-nut method with matchmarking techniques, the direct tension indicator method or the alternate design fastener (twist-off bolt) method.

b. Continuous monitoring: Monitoring of bolt installation for pretensioning using the calibrated wrench method or the turn-of-nut method without matchmarking shall be performed on a continuous basis.

3. Direct Tension Indicators: Observe all Direct Tension Indicators to see if proper tightness was achieved.

4. Standard Bolted Connections: Testing Agency shall inspect the installation of A307 bolts to verify that 10% of all bolts or a minimum of 2 bolts per connection are installed properly and tightened to a Snug-Tight (ST) condition.

F. Welded Connections:

1. Testing Agency shall be present during all welding operations. In addition to visual inspection, all shop-welded connections will be tested and inspected according to AWS D1.1 and this specification using the following inspection procedures:

a. Liquid Penetrant Inspection (PT): ASTM E165.

b. Magnetic Particle Inspection (MT): ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.

c. Ultrasonic Inspection (UT): ASTM E164.

d. Radiographic Inspection (RT): ASTM E94.

2. Visual Inspection of Welding: Testing Agency shall visually inspect all shop and field welding of structural steel accordance with the governing building code and AWS D1.1. Visual inspection of welds shall include but not be limited to the following:

a. Verify: Welding Procedure Specification (WPS) sheet has been provided and has been reviewed with each welder making the weld, welder qualification and identification, fit-up meets tolerances of WPS and mark joint prior to welding, welding consumables are per the Contract Documents and the WPS, amperage and voltage at the arc with hand-held meters, meters on welding equipment are functioning and accurate.

b. Observe preheat and interpass temperatures, weld pass sequence and size of weld bead.

c. Multi-pass shop and field welds shall be continuously inspected.

d. Visually inspect welds of heavy structural sections, or plates of 1-1/2 inch minimum thickness, at least 72 hours after completion of welding for the presence of cracks.

e. Visually inspect areas where backing bars and welds tabs are removed for conformance with the surface roughness criteria of the specifications.

f. Verify that the effective throat thickness of flare groove welds is consistently obtained when flush to bar or section. This verification shall be based on test sections where necessary.

3. Nondestructive Testing Requirements: Testing Agency shall perform non-destructive testing of shop and field welding in accordance with the project specifications, governing building code, and AWS D1.1. Extent of non-destructive testing shall be as follows:

a. Complete Joint Penetration (CJP) welds: UT 100% CJP welds

b. Partial Penetration Joint (PPJ) welds: UT 100% of PJP welds greater than 5/16-inch. UT 100% PJP in column splices.

c. Fillet Welds: MT 10% of the following fillet welds and reduce to 5% if no significant cracks are found in the first 50 tested of each type or configuration

d. Column Web Material at Continuity Plate: MT the WF column webs 3-inches above and below the weld terminations at the first 50 continuity plates and doubler plates installed. Test shall be conducted when weld has cooled to ambient temperature. If no web cracks are found, then no more testing required. This test shall also be conducted for all locations where the Contractor has welded into the “no weld” zone shown on the Drawings for continuity plates.

e. Access holes at splices in Heavy Structural Sections – MT or PT 100%.

G. Inspection Records

1. The inspector will maintain a daily record of the work that has been inspected and its disposition. One copy of each report will be submitted to the Owner on a weekly basis. Test reports will be made on the form suggested in the AWS D1.1 “Structural Welding Code”.
2. Make systematic record of all shop welds, including:

    a. Date of inspection.

    b. Location and type of weld.

    c. Identification marks of welders.

    d. List of defective welds.

    e. Manner of correction of defects.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify, with steel Erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

    1. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

B. Discrepancies: In the event of discrepancy, immediately notify the Owner’s Representative in writing. Do not proceed with construction in the region of the discrepancy until all such discrepancies have been resolved.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 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.

    1. The Contract Drawings indicate the completed structure. The Contractor is fully responsible for all temporary measures necessary for erection, except where specific sequences and requirements are specified on the Drawings. See the Drawings for erection sequence notes and minimum requirements.
    2. Provide temporary works as necessary to erect the structure and achieve proper alignment as erection proceeds. In addition, provide temporary bracing and shoring to brace the incomplete structure against loads such as wind and seismic forces comparable in intensity to the design loads for the completed structure.
    3. Make all necessary provisions for temporary bracing and for completion of erection where structural members are temporarily left out for erection at a later time.

4. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength where noted on the Drawings.

B. Furnish templates for exact locations of items to be embedded in concrete and any setting instructions required for installation

3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360. Check plumbness after erection of each tier.

B. Dimensions shown on drawings are based on an assumed design temperature of 70 degree F. Fabrication and erection procedures shall take into account the ambient temperature range at the time of the respective operations.

C. Where erection requires performing work of fabrication on site, comply with the applicable standards of Part 2 of this Specification.

D. Care shall be taken to protect work already installed from damages resulting from structural steel erection.

E. Items installed before concrete is placed shall be properly braced to prevent distortion by pressure of concrete. Watch and maintain bracing during concrete operations.

F. Base Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates. Remove any templates used for the setting of anchor bolts.

1. Set plates for structural members on wedges, shims, or setting nuts as required.

2. Weld plate washers to top of baseplate.

3. Snug-tighten anchor rods after supported members have been positioned and plumbed. If used, do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.

4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

G. Maintain erection tolerances of structural steel within AISC 303.

H. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.

2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

I. Splice members only where indicated.

J. Do not use thermal cutting during erection unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1.

K. Expansion Bolts:

1. Install in accordance with the manufacturer's recommendations.
2. Use washers on all bolts.
3. Use care to avoid cutting or damaging reinforcing bars.
4. When exposed to view in the final structure, bolts shall be of a length that will extend entirely through but not more than 1/4-inch beyond the nuts unless otherwise shown on the Drawings.

L. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts. Where a hole is required to be enlarged by more than 3/32-inch ream to and use next larger bolt size.

3.4 FIELD CONNECTIONS

A. Field connection requirements shall be as a minimum equal to those specified in Part 2 of this document.

B. Erection bolts for welded connection shall be tightened securely and left in place, unless noted otherwise.

C. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Pretensioned.

D. Weld Connections: Comply with AWS D1.1 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. Remove backing bars or weld tabs where indicated, back gouge, and grind steel smooth.

3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

4. Weld in manner to prevent warping or distortion of finished product. Use jigs which will not restrain piece from moving during welding or cooling after welding. Sequence weld passes at a joint to prevent excessive heat build-up or cause shrinkage cracks to form.

5. Auxiliary Member Connections and Temporary Welds shall be per AWS provided that preheating may be omitted on ASTM A36 steel for single pass fillet welds with low hydrogen electrodes under the following conditions: Air temperature is 60° F. or over, steel is dry, and welds to structural base material are more than 1" away from corners or ends of plates.

6. Preheat and post-heat procedures for welded joints shall be utilized to prevent rapid cooling of welds, particularly in cold weather. Procedures are Contractor's responsibility.

3.5 FIELD QUALITY CONTROL

A. Field quality control shall, as a minimum, conform to the requirements specified under Source Quality Control in Part 2.

B. Erection Tolerances: Unless otherwise noted, level and plumb individual members of the structure within a tolerance of 1:500, but not to exceed 1/2" for full height of columns. Make exterior columns and columns adjacent to elevator beams accurate within tolerance of 1:1000, but not to exceed 1/2" for full column height. Make level and plumb based on the mean operating temperature of the structure, allowing for the difference in temperature at time of erection and the mean temperature of the structure when completed and in service. Base measurements relating to tolerances on the theoretical centerline of the columns.

1. Columns: Gaps exceeding 1/8 inch between milled ends not permitted. Shim acceptable gaps with non-tapered mild steel shim stock.

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Verify structural-steel materials and inspect steel frame joint details.

2. Verify weld materials and inspect welds.

3. Verify connection materials and inspect high-strength bolted connections.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

C. Bolted Connections: Bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts."

1. The Inspector shall observe all Direct Tension Indicators to see if proper tightness is achieved.

D. Welded Connections: Field welds will be visually inspected according to AWS D1.1, the governing building code, and Part 2 of this document, by the Testing Agency.

1. In addition to visual inspection, test and inspect field welds according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

a. Liquid Penetrant Inspection: ASTM E 165.

b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.

c. Ultrasonic Inspection: ASTM E 164.

d. Radiographic Inspection: ASTM E 94.

E. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:

1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.

2. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

F. Defective Work:

1. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents. Work deemed defective will be removed from the site at the Contractor's expense.

2. Any special tests not specifically covered by this specification that are proposed by the Contractor as a result of failure to comply with this Section shall be at the Contractor's expense. The Contractor shall be responsible for any consequential costs or delays.

3. The results of those tests will be accepted, at the discretion of the Architect, as proof of adequate materials or workmanship.

3.6 REPAIRS AND PROTECTION

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A780.

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 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

2. Steel that remains exposed to the weather or to a corrosive atmosphere shall receive an additional coat of metal protection of another color after erection as required by the New York State Building Code.

C. Touchup Painting: Cleaning and touchup painting are specified in Division 09 "Exterior Painting" and "Interior Painting" Section.

D. Repair of Openings: For all members exposed to view in the final structure, close all lifting holes, access openings, etc. in such a manner that no visual evidence of the opening remains.

END OF SECTION

SECTION 052100

STEEL JOIST 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:

1. K-series steel joists.
2. KCS-type K-series steel joists.
3. K-series steel joist substitutes.
4. Joist accessories.

B. Related Sections:

1. Structural Steel Framing – Section 051200
2. Steel Decking – Section 053100
3. Painting – Division 09

1.3 DEFINITIONS

A. SJI's "Specifications": Steel Joist Institute's "Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders."

B. Special Joists: Steel joists or joist girders requiring modification by manufacturer to support nonuniform, unequal, or special loading conditions that invalidate load tables in SJI's "Specifications."

1.4 ACTION SUBMITTALS

A. Product Data: For each type of joist, accessory, and product.

B. Shop Drawings:

1. Include layout, designation, number, type, location, and spacing of joists.
2. Include joining and anchorage details; bracing, bridging, and joist accessories; splice and connection locations and details; and attachments to other construction.
3. Indicate locations and details of bearing plates to be embedded in other construction.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Welding certificates.

C. Manufacturer certificates.

D. Mill Certificates: For each type of bolt.

E. Comprehensive engineering analysis of special joists signed and sealed by the qualified professional engineer responsible for its preparation.

F. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists complying with applicable standard specifications and load tables in SJI's "Specifications."

1. Manufacturer's responsibilities include providing professional engineering services for designing special joists to comply with performance requirements

B. Welding Qualifications: Qualify field-welding procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle joists as recommended in SJI's "Specifications."

B. Protect joists from corrosion, deformation, and other damage during delivery, storage, and handling.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide special joists and connections capable of withstanding design loads indicated.

1. Use LRFD; data are given at factored-load level unless noted otherwise on drawings.

2. Design special joists to withstand design loads with live-load deflections no greater than the following:

a. Roof Joists: Vertical deflection of 1/240 of the span.

2.2 K-SERIES STEEL JOISTS

A. Manufacture steel joists of type indicated according to "Standard Specification for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members, underslung ends, and parallel top chord.

1. Joist Type: K-series steel joists.

B. Steel Joist Substitutes: Manufacture according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle or -channel members.

C. Provide holes in chord members for connecting and securing other construction to joists.

D. Top-Chord Extensions: Extend top chords of joists with SJI's Type S top-chord extensions where indicated, complying with SJI's "Specifications."

E. Extended Ends: Extend bearing ends of joists with SJI's Type R extended ends where indicated, complying with SJI's "Specifications."

F. Camber joists according to SJI's "Specifications."

G. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches.

2.3 PRIMER

A. Comply with Division 09 Section “Painting and Finishing”.

B. Primer: SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15, red-oxide color.

2.4 JOIST ACCESSORIES

A. Bridging: Provide bridging anchors and number of rows of horizontal or diagonal bridging of material, size, and type required by SJI's "Specifications" for type of joist, chord size, spacing, and span. Furnish additional erection bridging if required for stability.

B. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M,Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

1. Finish: Plain.

C. Welding Electrodes: Comply with AWS standards.

D. Furnish miscellaneous accessories including splice plates and bolts required by joist manufacturer to complete joist assembly

2.5 CLEANING AND SHOP PAINTING

A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories by hand-tool cleaning, SSPC-SP 2 or power-tool cleaning, SSPC-SP 3.

B. Apply one coat of shop primer to joists and joist accessories to be primed to provide a continuous, dry paint film not less than 1 mil thick.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates, embedded bearing plates, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Do not install joists until supporting construction is in place and secured.

B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications," joist manufacturer's written instructions, and requirements in this Section.

1. Before installation, splice joists delivered to Project site in more than one piece.

2. Space, adjust, and align joists accurately in location before permanently fastening.

3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.

4. Delay rigidly connecting bottom-chord extensions to columns or supports until dead loads are applied.

C. Field weld joists to supporting steel framework. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

D. Bolt joists to supporting steel framework using high-strength structural bolts. Comply with RCSC's "Specification for Structural Joints Using ASTM A325 or ASTM A490 Bolts" for high-strength structural bolt installation and tightening requirements.

E. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Visually inspect field welds according to AWS D1.1/D1.1M.

1. In addition to visual inspection, test field welds according to AWS D1.1/D1.1M and the following procedures, at testing agency's option:

a. Liquid Penetrant Inspection: ASTM E165/E165M.

b. Magnetic Particle Inspection: ASTM E709.

c. Ultrasonic Testing: ASTM E164.

d. Radiographic Testing: ASTM E94.

C. Visually inspect bolted connections.

D. Prepare test and inspection reports

3.4 PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.

B. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists and accessories.

1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

2. Apply a compatible primer of same type as primer used on adjacent surfaces.

C. Touchup Painting: Cleaning and touchup painting are specified in Division 09 “Exterior Painting” and “Interior Painting” Section.

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 this Section.

1.2 SUMMARY

A. Section Includes:

1. Roof deck.
2. Noncomposite form deck.

B. Related Sections:

1. Cast-in-Place Concrete – Section 033000
2. Structural Steel Framing – Section 051200
3. Steel Joist Framing – Section 052100
4. Metal Fabrications – Section 055000
5. Painting – Division 09

1.3 ACTION SUBMITTALS

A. Product Data: For each type of deck, accessory, and product indicated.

B. Shop Drawings:

1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Certificates: For each type of steel deck.

C. Product Test Reports: For tests performed by a qualified testing agency, indicating that each of the following complies with requirements:

1. Power-actuated mechanical fasteners.

D. Evaluation Reports: For steel deck, from ICC-ES.

E. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

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."

B. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 ROOF DECK

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, and with the following:

1. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade 40, G60 zinc coating.

2. Deck Profile: As indicated.

3. Profile Depth: As indicated.

4. Design Uncoated-Steel Thickness: As indicated.

5. Span Condition: As indicated.

6. Side Laps: Overlapped or interlocking seam at Contractor's option.

2.3 NONCOMPOSITE FLOOR DECK

A. Noncomposite Form Deck: Fabricate ribbed-steel sheet noncomposite form-deck panels to comply with "SDI Specifications and Commentary for Noncomposite Steel Form Deck," in SDI Publication No. 31, with the minimum section properties indicated, and with the following:

1. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade 40, G60 zinc coating.

2. Profile Depth: As indicated.

3. Design Uncoated-Steel Thickness: As indicated.

4. Span Condition: As indicated.

5. Side Laps: Overlapped or interlocking seam at Contractor's option.

2.4 ACCESSORIES

A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.

D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi, of same material and finish as deck, and of thickness and profile indicated.

G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.

H. Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.

I. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0598 inch thick, with factory-punched hole of 3/8-inch minimum diameter.

J. Flat Sump Plates: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck. For drains, cut holes in the field.

K. Recessed Sump Pans: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck, with 3-inch- wide flanges and recessed pans of 1-1/2-inch minimum depth. For drains, cut holes in the field.

L. Galvanizing Repair Paint: SSPC-Paint 20 or MIL-P-21035B, with dry film containing a minimum of 94 percent zinc dust by weight.

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 of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 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.

B. Install temporary shoring before placing deck panels if required to meet deflection limitations.

C. Locate deck bundles to prevent overloading of supporting members.

D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

1. Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.

E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

3.3 ROOF-DECK INSTALLATION

A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches long, and as follows:

1. Weld Diameter: 5/8 inch, nominal.

2. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds as indicated.

3. Weld Washers: Install weld washers at each weld location.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of one-half of the span or 12 inches, and as follows:

1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.

2. Mechanically clinch or button punch.

3. Fasten with a minimum of 1-1/2-inch- long welds.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:

1. End Joints: Lapped 2 inches minimum or butted at Contractor's option.

D. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and mechanically fasten flanges to top of deck. Space mechanical fasteners not more than 12 inches apart with at least one fastener at each corner.

1. Install reinforcing channels or zees in ribs to span between supports and weld or mechanically fasten.

E. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.

1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.

F. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.

3.4 FLOOR-DECK INSTALLATION

A. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:

1. Weld Diameter: 5/8 inch, nominal.

2. Weld Spacing: Weld edge ribs of panels at each support. Space additional welds an maximum of 12 inches apart

3. Weld Washers: Install weld washers at each weld location.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding 12”, and as follows:

1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.

2. Mechanically clinch or button punch.

3. Fasten with a minimum of 1-1/2-inch- long welds.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 2 inches, with end joints as follows:

1. End Joints: Lapped or butted at Contractor's option.

D. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations unless otherwise indicated.

E. 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.

F. Install piercing hanger tabs at 14 inches apart in both directions, within 9 inches of walls at ends, and not more than 12 inches from walls at sides unless otherwise indicated.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Field welds will be subject to inspection.

C. Prepare test and inspection reports.

3.6 PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.

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 at inside face of parapets.

5. Field inspection.

1.3 RELATED SECTIONS

A. Thermal Insulation - Section 072100.

B. Vapor permeable air barrier - Section 072700.

C. Metal Wall Panels - Section 074113.

D. 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 2020 BCNYS) with a maximum deflection of L/360 with metal panels.

1. For insulated metal panels, provide minimum 16-gauge studs, unless greater required by performance requirements above.

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.

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 New York State Building Code 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. Header for Window and Door Openings: 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: 5/8" thick "Dens-Glass Fireguard," Type X, 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, Type X.

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. OSHA compliant vertical steel ladders.
3. OSHA compliant alternating tread devices.
4. Core for Adobe clad doors, coordinate with Division 8.
5. Steel pipe handrails and railings not part of steel pan stair assemblies.
6. Loose bearing and leveling plates.
7. Light steel framing and supports not included as part of work of other trades.
8. Steel gratings and frames.
9. Structural steel door frames at service doors.
10. Furnishing stair nosings for interior concrete stairs.
11. Miscellaneous steel trim.
12. Countertop supports.
13. Trench drains.
14. Sleeves in concrete walls and slabs.
15. 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.
16. Prime painting, touch-up painting, galvanizing and separation of dissimilar metals for work of this Section.
17. 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 2020 Building Code New York State.

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 that 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 (coordinate with Section 099000): 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

1. 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.

2. 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. Alternating Tread Devices

1. Alternating Tread Devices: Fabricate alternating tread devices of open-type construction with channel or plate stringers and pipe and tube railings unless otherwise indicated. Provide brackets and fittings for installation.

   a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
      1). Lapeyre Stair Inc.
      2). Schmidt Structural Products, Inc.

   c. Tread depth shall be not less than 5 inches exclusive of nosing or less than 8-1/2 inches including the nosing, tread width shall be not less than 7 inches, and riser height shall be not more than 9-1/2 inches.
   d. Tread depth shall be not less than 8-1/2 inches exclusive of nosing or less than 10-1/2 inches including the nosing, tread width shall be not less than 7 inches, and riser height shall be not more than 8 inches.
   e. Fabricate from steel and assemble by welding or with stainless-steel fasteners.
   f. Railings comply with below.

2. Galvanize exterior steel alternating tread devices, including treads, railings, brackets, and fasteners.

3. Prime exterior steel alternating tread devices, including treads, railings, brackets, and fasteners, with zinc-rich primer.

D. Steel Pipe Handrails

1. Steel pipe of size shown on Drawings, Schedule 40. Fittings shall be flush type, malleable of cast iron. Brackets shall be malleable iron, design as selected by the Architect.

2. 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.

3. 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.

4. Provide wall return fittings of cast iron, flush type, with the same projection as that specified for wall brackets.

5. 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.

6. 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.

7. 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.

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. Steel Gratings and Frames: Provide hot dipped galvanized steel gratings complying with FS RR-G-661 with rectangular cross bars welded to bearing bars. Bars to have plain wearing surface.

1. Manufacturer: Provide gratings manufactured by Reliance, Borden, Irving Subway Grating, or approved equal.

2. Hinged Section: Provide hinged sections in areaway gratings where required by the drawings. Each hinged section up to 4'-0" wide shall be provided with two (2) five knuckle, fast pin, regular weight, plain bearing, wrought bronze butt hinges. Each hinged section over 4'-0" wide shall be provided with three (3) butt hinges. Hinged sections shall have provisions for padlocking on the underside.

3. Furnish grating frames, with corners mitered, welded and ground smooth, and with welded-on straps for secure anchorage into concrete. Frames and anchors to be galvanized.

4. Structural Performance: Provide gratings capable of withstanding the following structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections:

   a. Floors: Capable of withstanding a uniform load of 250 lbf/sq. ft. or a concentrated load of 3000 lbf, whichever produces the greater stress.
   b. Walkways and Elevated Platforms Other Than Exits: Capable of withstanding a uniform load of 60 lbf/sq. ft. Limit deflection to L/360 or 1/4", whichever is less.
   c. Walkways and Elevated Platforms Used as Exits: Capable of withstanding a uniform of 100 lbf/sq. ft. or a concentrated load of 300 lbf on an area of 4 sq. in., whichever produces the greater stress. Limit deflection to L/360 or 1/4", whichever is less.
   d. Sidewalks and Vehicular Driveways: Capable of withstanding a uniform load of 250 lbf/sq. ft. or a concentrated load of 8000 lbf, whichever produces the greater stress.

H. Structural Steel Door Frames

1. Fabricate steel door frames of structural shapes and bars, fully welded, uniform, square and true. Plug weld built-up members, continuously weld exposed joints; grind exposed welds smooth. Provide 5/8" x 1-1/2" steel bar stops. Secure removable stops to frame with countersunk machine screws, uniformly spaced at not more than ten (10) inches o.c.

2. Provide necessary reinforcements and drill and tap as required for finish hardware.

3. Provide steel strap anchors for securing door frames into adjoining concrete or masonry, using 1/8" x 2" straps of the length required for a minimum eight (8) inch embedment. Weld anchors to frame jambs no more than twelve (12) inches from both bottom and head of frame and space anchors not more than thirty (30) inches apart.

4. Extend bottom of frames to floor elevation and secure to concrete with steel angle clips welded to frames, anchored with expansion shields and bolts.

I. Safety Nosings for Concrete Stairs

1. Provide three (3) inch wide, Style A cast iron safety nosing with hatched abrasive surface extending to end of stringers, manufactured by American Abrasive Metals Co., or equal made by Wooster Products Inc., American Mason Safety Tread Co., or approved equal.

2. Provide anchors spaced not more than four (4) inches from each end and not more than twelve (12) inches o.c. Furnish nosings to concrete trades for installation.

3. Apply asphaltic coating to surfaces in contact with concrete.

J. 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.

K. 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.

L. Trench Drains: Provide Series R-4999 trench frame with Type A grated cover (unless otherwise noted on drawings), heavy duty, made of ductile iron as manufactured by Neenah Foundry Co., or approved equal, sizes as shown on drawings. Assembly shall have asphalt coating. Grate shall be bolted in place with stainless steel hex head cap screws.

M. 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. 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.

2. Nonslip-Aggregate Finish: Factory-packaged abrasive aggregate made from fused, aluminum-oxide grits or crushed emery; rustproof and nonglazing; unaffected by freezing, moisture, or cleaning materials.

3. 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 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. Stainless steel handrails and railings.

2. Blackened steel.

3. Safety screen for pellet stove at Pond.

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 inch x 12 inch 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.

1.6 PERFORMANCE REQUIREMENTS

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.

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.

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 surfaces that exhibit pitting, seam marks, roller marks, oil-canning, stains, discolorations, or other imperfections on the finished units will not be acceptable.

B. 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 316.

2. Pipe: ASTM A 312, Grade TP 316.

3. Castings: ASTM A 743A, Grade CF 8M or CF 3M.

4. Sheet, Strip, Flat Bar and Plate: ASTM A 666, Type 316.

5. Bars and Shapes: ASTM A 276, Type 316.

C. Steel and Iron: Comply with the following standards for the forms and types of steel and iron for the required items of work.

1. 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.

D. 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.

E. 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.

F. 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.

G. Bituminous Paint: SSPC-Paint 12 (cold-applied asphalt mastic).

H. 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.

I. 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).

J. 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.

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. 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. 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.

E. Supplementary Parts: Provide as necessary to complete each item of work, even though such supplementary parts are not shown or specified.

F. 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.

G. 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.

H. 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.

I. 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".

2. Knife Edge Bends: Back-cut and back bevel sheets to attain sharpest bend possible, with maximum radius of 1/32".

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. 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. Finish: As indicated on drawings.

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.

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 the New York State 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 AND PROTECTION

A. Clean steel and stainless steel by washing thoroughly with clean water and soap and rinsing with clean water.

B. 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.

C. 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 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 mechanical and electrical closets.
3. Rough hardware.
4. Installation only of finish hardware.
5. Installation only of doors and hollow metal frames.

1.3 RELATED SECTIONS

A. Wood Frame Construction - Section 061000.

B. Architectural Woodwork - Section 064023.

C. Roofing - Section 075419.

D. Steel Doors and Frames - Section 081113.

E. Wood Doors - Section 081416.

F. Finish Hardware - Section 087100.

1.4 QUALITY ASSURANCE

A. Submit FSC chain of custody certification.

B. Lumber Standard: Comply with PS 20.

C. Plywood Standard: Comply with PS 1 and American Plywood Assoc. (APA).

D. Shop fabricate carpentry work to the extent feasible and where shop fabrication will result in better workmanship than feasible for on-site fabrication.

E. 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.

F. 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.

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 and rough carpentry for mechanical 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. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with mortar; refer to Section 042000 "Unit Masonry" for installation of frames in masonry walls.

6. 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.

7. Installation Tolerances: Adjust steel door frames for squareness, alignment, twist, and plumb to the tolerance given in HMMA 841 of ANSI/NAAMM, current edition.

8. 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.

9. 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. 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 MECHANICAL AND ELECTRICAL EQUIPMENT MOUNTING BOARDS

A. Furnish and install 3/4" thick plywood panels to the walls of the mechanical 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.

3.6 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.

3.7 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. Wood veneer wall paneling.
2. Wood slat ceilings.
3. Wood baseboard (flat – no profiles), window jamb, sill surrounds – matching window finish.
4. Wood millwork and counters with wood.
5. Wood millwork and counters with plastic laminate finish.
6. Hardware for architectural woodwork.
7. Wood shelving.
8. Solid surfacing countertops.
9. Solid White Oak wood countertops.
10. Wood framing and rough lumber as required for work of this Section.
11. Wood grounds, blocking, nailers, furring as required for work of this Section.
12. All rough hardware and fastenings for work of this Section.
13. Drilling concrete and masonry, drilling and/or tapping metal work, as required, for the installation of work of this Section.
14. Back painting as specified herein.
15. Shop finish 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.

1.4 QUALITY STANDARDS

A. Submit FSC chain of custody certification.

B. 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.

C. 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.

D. Employ only tradesmen experienced in the fabrication and installation of architectural woodwork.

E. 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.

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 finish type of wood slat for ceilings, 12-inch length.

6. Each type and finish of each type of wood trim, eight (8) inches long, finish as specified.

7. 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.

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 White Oak (wlecon Center, Adobo wood ceiling, tongue & groove) 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: 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. Architect's control samples for transparent finish, veneer grain and figure characteristics are available for review at the office of the Architect.

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 unless otherwise noted on drawings.

I. Finishing (Wood)

1. Transparent Finish

a. AWI Factory Finish System "Conversion Varnish, System 5, Transparent."
b. AWI Premium Grade.
c. Stain: Clear.
d. Degree of Sheen: Matte.

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.

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 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 083000.

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 WOOD 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 white oak, eased edges.

2. Exposed Counter Edges: Painted edges.

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.

2.10 HARDWARE (SEE DRAWINGS)

A. Architectural Woodwork Hardware: Provide the following items, or their approved equal, as required:

1. Hinges: Hafele concealed hinges, soft close.

2. Catches: Magnetic; top and bottom.

3. Pulls: Selected by the Architect.

4. Locks: Directed by the Architect.

5. Drawer Slides

   a. 24" Maximum Width: Accuride, Model 7434, full extension, 100 lb. capacity.
   b. 16" Maximum Width, Easy Close: Accuride Model 3832C, full extension, 100 lb. capacity.

6. Shelf Supports: Pin and grommet system equal to No. 282.01.701 pin and 282.50.704 grommet made by Hafele.

7. Finish: Satin stainless steel.

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 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.

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. Wood Slat Ceilings:

1. reSAWN Timber co,, to match wood siding unless otherwise noted.

2. reSAWN Timber Adobo tongue and groove ceiling at Ticketing and White Oak tongue and groove ceiling at Admin.

D. 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.

E. 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 WOOD TRIM

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 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.

3.9 CLOSET AND STORAGE SHELVING

A. Provide closet and storage shelving at the locations shown. Provide hang rods where shown. Set adjustable center hangers.

3.10 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.

3.11 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.

3.12 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.

3.13 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.

3.14 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

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 foundation wall surfaces.

2. Sheet membrane waterproofing for under-slab conditions.

1.3 RELATED SECTIONS

A. Cast-in-Place Concrete - Section 033000.

B. Site Excavating, Backfilling and Compacting - Section 312300.

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.

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.

E. completion for the waterproofing and any other relevant or adjacent work

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 in. 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. Other acceptable manufacturers will be Carlisle Coatings and Waterproofing (CCW), Henry Company or approved equal.

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 "Bituthene 300R Plus" system by GCP Applied Technologies or approved equal.

1. 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. 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.

E. Bituthene Elastomeric Mastic: Rubberized asphalt base mastic.

F. Tape: Double sided synthetic adhesive tape equal to "Preprufe LT" and "HC."

G. Protection Board: 1/4" thick semi-rigid protection board, "Bituthene Asphaltic Hardboard."

H. Bituthene Liquid Membrane: Two-component 100% solids trowel grade asphalt modified urethane.

I. 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 SEAM REINFORCEMENT FOR HDPE COMPOSITE SHEETS ONLY

A. Provide a 6 in. 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 in., apply a 1/8 in. thick by 6 in. wide application of liquid membrane between sheets, to provide a 6 in. 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 in., apply a 1/8 in. thick by 12 in. wide application of fluid membrane between sheets, to provide a 12 in. 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. 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 in. of sound material around it, inject Liquid Membrane into puncture until Liquid Membrane backs out, and proceed with patch as space allows.

3.6 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 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. Work of this Section includes all labor, materials, equipment, and services necessary to complete the insulation as indicated on the drawings and/or specified herein, including, but not limited to, the following:

1. Mineral Wool Blanket Insulation.
2. Mineral Wool Board Insulation.
3. Extruded Polystyrene Foam-Plastic Board Insulation.

1.3 RELATED SECTIONS

A. Exterior Self-Adhering Sheet Barriers – Section 072700

B. Exterior Insulated Metal Panel System – Section 074213

C. Exterior Rain Screen Cladding Systems – Section 074450

D. Sheet Metal Flashing – Section 076200

E. Exterior Overhead Coiling Doors – Section 083323

F. Exterior Metal Framed Windows – Section 085100

G. Exterior Wood Framed Windows & Doors – Section 085200

H. Unit Skylights – Section 086200

I. Metal Framed Skylights - 086300

J. Louvers – Section 089000

K. Cement Plastering – Section 092400

1.4 ACTION SUBMITTALS

A. Product Data: For each insulation type and accessories.

B. Sustainable Design Submittals: Refer to 018113 Sustainable Design Requirements

1.5 INFORMATIONAL SUBMITTALS

A. Installer's Certification: Listing type, manufacturer, and R-value of insulation installed in each element of the building thermal envelope.

1. Sign, date, and post the certification in a conspicuous location on Project site.

B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

C. Research Reports: For foam-plastic insulation, from ICC-ES.

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. Protect foam-plastic board insulation as follows:

1. Do not expose to sunlight except to necessary extent for period of installation and concealment.

2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.

3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 STONE-WOOL INSULATION

A. General Compliance: ASTM C612.

1. R-value: 4.3 per inch thickness when tested in accordance with ASTM C518.

2. Flame-Spread Index: Not more than 0 when tested in accordance with ASTM E84.

3. Smoke-Developed Index: Not more than zero when tested in accordance with ASTM E84.

4. Non-combustible: Comply with ASTM E136.

5. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.

6. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Rockwool International.

    b. Thermafiber, Inc.; an Owens Corning company.

B. Insulation at Exterior Rain Screen Cavity Walls:

1. Type: Semi-Rigid Stone Wool Board Insulation: Type IVA or IVB Compliant, unfaced.

2. Overall thickness: As required to meet thermal performance and as indicated on drawings.

3. Basis of Design: Cavityrock by Rockwool.

    a. Minimum Density: 6 lb/cu. ft.

C. Insulation at Exterior Metal Rain Screen Walls:

1. Type: Rigid Stone Wool Board Insulation: Type IVA or IVB Compliant, unfaced.

2. Overall thickness: As required to meet thermal performance and as indicated on drawings.

3. Basis of Design: Comfortboard 110 by Rockwool.

    a. Minimum Density: 8 lb/cu. ft.

2.2 MINERAL WOOL INSULATION

A. General Compliance: ASTM C665.

1. R-value: 4.0 per inch thickness when tested in accordance with ASTM C518.

2. Flame-Spread Index: Not more than 0 when tested in accordance with ASTM E84.

3. Smoke-Developed Index: Not more than zero when tested in accordance with ASTM E84.

4. Non-combustible: Comply with ASTM E136.

5. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.

6. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Rockwool International.

    b. Thermafiber, Inc.; an Owens Corning company.

B. Insulation within Stud Wall Cavity:

1. Type: Semi-Rigid Mineral Wool Batt Insulation: Type I

2. Overall thickness: As required to meet thermal performance and as indicated on drawings.

3. Basis of Design: Comfortbatt Thermal Batt Insulation by Rockwool.

    a. Minimum Density: 2 lb/cu. ft

2.3 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD INSULATION (XPS)

A. Insulation at base of Rain Screen Walls:

1. Type: Extruded Polystyrene Board Insulation, Type VII: ASTM C578, Type VII, 60-psi minimum compressive strength.

2. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.

3. Smoke-Developed Index: Not more than 450 when tested in accordance with ASTM E84.

4. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.

2.4 INSULATION FASTENERS

A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.

1. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

2. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation.

B. Adhesively Attached, Angle-Shaped, Spindle-Type Anchors: Angle welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.

1. Angle: Formed from 0.030-inch-thick, perforated, galvanized carbon-steel sheet with each leg 2 inches square.

2. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation.

C. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized-steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches square or in diameter.

1. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in the following locations:

    a. Ceiling plenums.

D. Insulation Standoff: Spacer fabricated from galvanized mild-steel sheet for fitting over spindle of insulation anchor to maintain air space of 1 inch between face of insulation and substrate to which anchor is attached.

E. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates without damaging insulation, fasteners, or substrates.

2.5 ACCESSORIES

A. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Install insulation with manufacturer's R-value label exposed after insulation is installed.

D. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

E. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.3 INSTALLATION OF CAVITY-WALL INSULATION

A. Mineral-Wool Board Insulation: Install insulation fasteners 4 inches from each corner of board insulation, at center of board, and as recommended by manufacturer.

1. Fit courses of insulation between obstructions, with edges butted tightly in both directions, and with faces flush.

2. Press units firmly against inside substrates.

3.4 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

A. 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. Attics: Install eave ventilation troughs between roof framing members in insulated attic spaces at vented eaves.

5. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.

3.5 PROTECTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes.

B. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 072100

SECTION 072120

THERMAL INSULATION (BELOW GRADE)

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 below grade thermal insulation as shown on the drawings and/or specified herein, including, but not limited to, the following:

1. Insulation under slabs-on-grade.

2. Foundation wall insulation.

3. Attachment devices.

1.3 RELATED SECTIONS

A. Unit Masonry - Section 042000.

B. Roof insulation - Division 7.

C. Above grade insulation - Section 072100.

D. Firestops and Smokeseals - Section 078413.

E. Gypsum Drywall - Section 092900, for acoustical insulation.

F. 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 AND UNDERSLAB 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; thickness as noted on the drawings.

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 below grade 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 BELOW-GRADE INSULATION

A. On vertical surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.

1. If not otherwise indicated, extend insulation a minimum of 24" below exterior grade line.

B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

1. If not otherwise indicated, extend insulation a minimum of 36" in from exterior walls.

3.4 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 072616

BELOW-GRADE VAPOR RETARDER

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 below-grade vapor retarder as shown on the drawings and/or specified herein, including but not limited to the following:

1. Underslab vapor retarder below slab on grade.

2. Confirm that the substrates for the below-slab vapor retarder are acceptable.

3. Integrate the vapor retarder with all surrounding work; coordinate all work with related trades.

4. Provide all necessary permits and fees for this work, including building permits, inspection fees, police detail, etc.

1.3 RELATED SECTIONS

A. Review specifications for related work for purposes of coordination.

B. Work in conjunction with the other trades employed on the project by promptly completing the work of this Section as required to meet the project schedule and so as not to impede other trades. Coordinate the work of this Section with other trades so that the intent of the Drawings and Specifications is carried out. Coordinate with other trades to maximize efficient use of scaffolding, to minimize disruption to the building, and to avoid unnecessary traffic over unprotected roof areas.

1.4 QUALITY ASSURANCE

A. Conduct a quality control program that includes the following as a minimum:

1. Inspect conditions and materials to ensure conformity to the contract requirements.

2. Continuously inspect substrate conditions and coordinate with the Architect to ensure proper substrate preparation in conformance with the contract requirements.

3. The Contractor shall arrange with the vapor retarder manufacturer to have a competent field representative visit the site to inspect the workmanship and the quality of the work. The manufacturer should visit the site as required to observe the progress of the work, but at least three times during the course of the project. The field representatives shall issue written reports of their findings and recommendations for corrective work, if any, to the Architect. The Contractor shall include all costs for the field representative, including all expenses, in the project bid price.

a. The representative shall review and approve the condition of substrates prior to application of vapor retarder.

b. The representative shall observe the first one to two days of application of vapor retarder.
c. Representative shall review and approve below-slab-vapor-retarder conditions prior to pouring concrete.

4. Inspect work in progress and during inclement weather to ensure that the work is in compliance with approved procedures.

5. Inspect all completed and any corrected work for compliance with the Contract Documents and the vapor retarder manufacturers' recommendations.

B. The vapor retarder system shall be applied by an approved contractor authorized by the vapor retarder manufacturer to perform the work.

C. Attend a preconstruction conference to be held with representatives of the Owner, Contractor, Architect, and all other involved trades and parties to discuss the work covered under this Section.

D. Attend weekly job meetings during the course of the work as required by the Owner.

E. The Contractor/Subcontractor and its site superintendent(s) and Foreman shall have at least five years' experience with similar vapor retarder and flashing work with success.

1.5 SUBMITTALS

A. Submit the following items in time to allow for review by the Architect and resubmittals, if needed, without delaying the work. Do not order materials or start work before receiving the Architect's written approval.

1. Shop drawings of all conditions and details, including connection to all surrounding work and isometric (3D) details of complex conditions. Include work sequence for conditions between work of this Section and surrounding work; coordinate with related trades.

2. Contractor's qualifications.

3. Samples and/or manufacturer's literature for all materials specified or proposed for use on the project, properly labeled and referenced to the appropriate specification section. Samples required include, but are not limited to, the following:

a. Vapor retarder.
b. Seam tape.
c. Protection layer.
d. Any product or material proposed for substitution.

4. Certifications (in time for review to prevent delay in the work) by the producers of all materials stating that the materials supplied comply with all the requirements of the referenced standards and that all materials are suitable for the use specified herein.

5. Material Safety Data Sheets (MSDS) for each material where appropriate.

6. Project Schedule and Sequencing. Submit updated project schedule weekly throughout the project to reflect current status and project schedule.

7. Vapor retarder manufacturer's sample guarantees.

1.6 DELIVERY, STORAGE, AND HANDLING

A. The Contractor is responsible for protecting all materials and equipment stored on the site.

B. All materials to be new. Handle all materials to prevent damage. Place materials on pallets. Use waterproof and fireproof canvas tarpaulins (not polyethylene) to cover all stored materials top to bottom.

C. Deliver materials clearly marked with legible and intact labels with manufacturer's name and brand name and identifying contents of containers.

D. Materials shall be marked with the date of manufacture and shelf life. Do not use products beyond the expiration of their shelf life.

E. Protect all materials in original unopened labeled containers and packaging and in compliance with manufacturer's directions. Comply with manufacturer's recommendations for minimum and maximum time and temperature limits for storage. Store flammable materials in a cool, dry, protected area away from sparks and open flames.

F. Promptly remove from the site all materials rejected by the Architect or exposed to any moisture anywhere, at any time, during transportation, storage, handling, and installation.

G. Do not stockpile materials or equipment to overload any building or site component.

H. Protect materials from deterioration by moisture and temperature. Store in a dry location or in waterproof containers. Keep containers tightly closed when not in use and away from open flames. Protect liquid components from freezing.

I. Store rolled goods on ends only. Discard rolls that have been flattened, creased, or otherwise damaged. Unroll sheets and allow them to "relax" prior to use.

J. Do not dilute primers, waterproofing cements, adhesives, coatings, or sealants. Keep containers closed, except when removing materials. Do not use equipment that is contaminated with materials that may be incompatible with the work.

K. Dispose of debris as required by state and local ordinances. All debris shall be removed from the site and the site returned to its original condition upon completion of the project.

L. Do not allow wrappers, packaging materials, or any other debris to be included in the vapor retarder system.

1.7 PROJECT CONDITIONS

A. Coordinate the work, use of the site, storage areas, and staging areas with the Contractor. Limit use of the site and working hours to dates, times, and locations approved by the Contractor.

B. All equipment used on the project shall comply with all applicable municipal and safety regulations – including OSHA guidelines – and be suitable for reasonable access for inspection of the Owner's representative, who shall have free access to the work via the Contractor's equipment.

C. Compliance with OSHA and all other safety laws and regulations is the exclusive responsibility of the Contractor, its Subcontractors, suppliers, consultants, and servants.

1.8 WARRANTY/GUARANTEE

A. Guarantee all work under this Section in a document stating that if, within two years after the Date of Substantial Completion of the Work, any of the work of this Section is found to be defective or not in accordance with the Contract Documents, the Contractor shall, at its sole cost and expense, correct it promptly after receipt of a written notice from the Owner to do so, unless the Owner has previously given the Contractor a written acceptance of such condition. Also, state that the Contractor shall bear all costs incurred by the Owner, including reasonable attorney's fees, court costs, and expert witness and consultant fees, to

enforce Contractor's compliance with the obligations of this Guarantee. The obligations of this Guarantee shall run directly to the Owner and its successors and assigns and may be enforced by the Owner and its successors and assigns 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 GENERAL

A. Check the availability of all specified items early and report any long lead times that may impact the intended schedule to the Owner promptly to prevent delays in the work.

B. All materials are to be new. Handle, store, and install materials as recommended by the manufacturer. Materials shall be delivered to the job site in their original containers with the manufacturer's name, grade, number, and batch identification on the container or packaging.

2.2 MATERIALS

A. Unless approved by the Architect, obtain all vapor retarder materials from the same manufacturer. All components of the vapor retarder system shall be as manufactured by, or approved by, the vapor retarder manufacturer and will be included in the vapor retarder system manufacturer's warranty.

2.3 MATERIALS

A. Unless approved by the Architect, obtain all vapor retarder materials from the same manufacturer. All components of the vapor retarder system shall be as manufactured by, or approved by, the vapor retarder manufacturer.

B. At under-slab conditions, provide moisture barrier cover over prepared base material where indicated in accordance with ASTM E1643. Use only materials which are resistant to decay when tested in accordance with ASTM E154, as follows:

1. Vapor Retarder: Polyethylene sheet not less than 20 mils thick, which complies with ASTM E1745, Class B. Include manufacturer's recommended adhesive or pressure sensitive tape. Acceptable products include:

   a. Permeance Rating: Less than 0.1 Perms (ASTM F1249) as tested after mandatory conditioning (ASTM E1745, Paras. 7.1.2-5).

2. Approved Manufacturers:

   a. Stego Industries, LLC; Stego Wrap, 15 mil.
   b. Or approved equal.

C. Joint Sealer Tape: Stego Tape by Stego Industries, LLC., by one of manufacturers listed above or approved equal.

D. Mastic: Stego Mastic by Stego Industries, LLC. by one of manufacturers listed above or approved equal.

E. Termination Bar: 14 ga. galvanized steel bar with stiffening ribs along outer edges, 1 in. wide, prepunched bar stock, spacing of holes as indicated in Drawings; Sarnabar by Sarnafil, Inc., by one of manufacturers listed above or approved equal.

1. Fasteners for Termination Bar: 1/4" diameter Tapcons with Stalgard corrosion resistant finish (color blue).

F. Hose Clamp: Stainless steel, worm drive.

PART 3 EXECUTION

3.1 GENERAL WORKMANSHIP

A. Vapor retarder systems shall be installed by contractors specifically authorized by the appropriate manufacturer prior to bid. Perform all work with trained personnel.

B. Arrange work sequence to avoid use of newly constructed vapor retarder for storage, walking surface, and equipment movement. Where access is absolutely required, protect surfaces with smooth 1/2" thick plywood runways to ensure full protection of vapor retarder surfaces and all other work against mechanical damage. Provide additional protection if needed to prevent damage. Move equipment and ground storage areas as work progresses to avoid abuse of completed vapor retarder.

C. Replace any new materials scheduled to remain that are damaged due to weather or other causes during the period of the work at no additional cost to the Owner. If water causes damage, remove and replace all wet materials at no additional cost to the Owner.

D. Do not work in temperatures below 40°F. Comply with applicable recommendations by manufacturers of all materials and workmanship and handling, except as modified in this Section.

E. Promptly remove from the site all damaged, defective, or rejected materials. Remove from the site all materials rejected by the Owner or Architect.

F. Components of the vapor retarder system may be toxic and flammable. Heed all manufacturer’s cautions and warnings concerning their use. Completed vapor retarder is slippery when wet or frost covered. Take proper precautions.

G. Do not use equipment for vapor retarder installation that is contaminated with materials that may be incompatible.

H. Workers and all others that walk on the waterproofing membrane shall wear clean soft-soled shoes so as not to damage vapor retarder and related materials.

3.2 REPAIR AND PREPARATION OF SURFACES TO RECEIVE VAPOR RETARDER

A. General

1. Examine all surfaces scheduled to receive vapor retarder for roughness, contaminants, unsound structural substrates, or other conditions that may impair the vapor retarder application. Notify the Architect in writing of any such conditions; do not commence work until all defects are remedied.

2. Clean the all substrates of all foreign substances and remove loose materials, grease, oil, and other contaminants. The vapor retarder contractor and manufacturer shall inspect and approve the substrates before application of the vapor retarder system.

B. For horizontal surfaces to receive vapor retarder, the earth and crushed stone substrates shall be compacted to produce an even, sound substrate. Loose aggregate, sharp protrusions, and standing water shall be removed.

3.3 VAPOR RETARDER INSTALLATION

A. General

1. Conform to recommendations and published specifications of the manufacturer, including environmental requirements.

2. Do not allow water to pond on vapor retarder. Promptly remove water that collects on vapor retarder with vacuum or other method acceptable to Architect.

B. Installation of Below-Slab Vapor Retarder

1. Install a continuous layer of protection layer over the substrate immediately before installing the vapor retarder. Overlap sheets of protection layer approximately 4 in. Stagger laps between protection layer and vapor retarder.

2. Vapor Retarder Installation: Below-slab vapor retarder shall be applied horizontally over the substrate. Minimize joints between sheets of vapor retarder to the greatest extent practical, without inhibiting the work. Overlap ends of sheets a minimum of 6 in. Overlap subsequent sheets 6 in. The below-slab vapor retarder sheets shall extend minimum 24 in. (or more if required on Drawings) past the future edge of the slab to allow for effective joining of the below-slab vapor retarder with foundation waterproofing.

3. Cleaning Edges and Seams: All lap/seam areas shall be fully cleaned prior to taping. If contaminated by dust, debris, water, or other contaminants, fully clean the seam with the cleaner recommended by the manufacturer and allow the seam area to fully dry before completing the seam.

4. Sealing Seams and Edges: Install seam tape within all seams. Provide a continuous unbroken seal. Roll seams with a rubber roller with moderate pressure; achieve continuous adhesion.

5. Sealing Penetrations: Penetrations shall be flashed with prefabricated pipe boots to the greatest extent practicable. Other penetrations shall be fully wrapped with vapor retarder material. Seal all seams and edges with seam tape. Provide stainless steel hose clamps at round penetrations.

6. T-Joints: Take extra care at T-joints to ensure that pinhole tunnels are not created. Install an additional patch of seam tape if needed.

7. Inside Corner Forming: Vapor retarder at inside corners shall be folded and creased (not cut) to the greatest extent practicable. The folded flap shall be taped in place with seam tape.

8. Joining and Sealing Below-Slab Vapor Retarder with Foundation Wall Waterproofing: Follow Drawings and manufacturer's installation instructions and ensure that all joints are fully and continuously sealed.

   a. After concrete is poured, secure and seal top of below-slab vapor retarder to foundation with two rows of seam tape and termination bar (fastened 8 in. o.c.) installed 2 in. below the top edge; seal the top edge. Foundation wall waterproofing shall shingle over vapor retarder a minimum of 12 in.; seal edge.

3.4 VAPOR RETARDER INSPECTION AND REPAIR

A. Inspection and repair of the below-slab vapor retarder system shall occur before installation of the reinforcement steel, before installation of formwork, and prior to placement of the concrete. Punctures shall be repaired as follows:

1. Clean surface with damp cloth, or water jet if required. Allow to dry.

2. For pinholes, apply repair tape, centered over puncture, roll firmly, remembering to remove release liner.

3. For damage other than pinholes, apply vapor retarder patch that extends 6 in. beyond opening; seal edges with seam tape.

4. Remove and reinstall concrete reinforcement if required for installation of patch.

3.5 CLEAN-UP

A. Upon completion of the vapor retarder system, the General Contactor shall remove all equipment, material, and debris from the work and storage area, and leave those areas in an undamaged and acceptable condition.

B. All water shall be removed from the vapor retarder before placement of concrete.

END OF SECTION

SECTION 072700

SELF-ADHERING SHEET AIR BARRIERS

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 insulation as indicated on the drawings and/or specified herein, including, but not limited to, the following:

1. Vapor Impermeable Bituminous Sheet Air Barrier

2. Vapor Permeable Bituminous Sheet Air Barrier

1.3 RELATED SECTIONS

A. Exterior Thermal Insulation (Above Grade) – Section 072100

B. Exterior Insulated Metal Panel System – Section 074213

C. Exterior Rain Screen Cladding Systems – Section 074623

D. Sheet Metal Flashing – Section 076200

E. Exterior Overhead Coiling Doors – Section 083323

F. Exterior Metal Framed Windows – Section 085100

G. Exterior Wood Framed Windows & Doors – Section 085200

H. Unit Skylights – Section 086200

I. Metal Framed Skylights - 086300

J. Louvers – Section 089000

K. Cement Plastering – Section 092400

1.4 DEFINITIONS

A. Air-Barrier Material: A primary element that provides a continuous barrier to the movement of air.

B. Air-Barrier Accessory: A transitional component of the air barrier that provides continuity.

C. Air-Barrier Assembly: The collection of air-barrier materials and accessories applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.

1.5 PERFORMANCE REQUIREMENTS

A. Air-Barrier Performance: Air-barrier assembly and seals with adjacent construction shall be capable of performing as a continuous air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, tie-ins to installed waterproofing, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

B. Air-Barrier Assembly Air Leakage: Maximum 0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft., when tested according to ASTM E2357.

C. Fire Resistance: Evaluated to NFPA 285 as part of various wall assemblies.

D. The air barrier assembly shall be capable of withstanding combined design wind, fan and stack pressures, both positive and negative on the envelope without damage or displacement, and shall transfer the load to the structure.

1. Wind loads: Provide air-barrier capable of withstanding wind load design pressures provided in Wind Tunnel Study.

E. The air barrier assembly shall be joined in an airtight and flexible manner to the air barrier materials of adjacent assemblies, allowing for the relative movement of assemblies due to thermal and moisture variations, creep, and anticipated seismic movement.

F. Connections to Adjacent Materials: Provide connections to prevent air leakage at the following locations:

1. Foundation and walls, including penetrations, ties and anchors.

2. Walls, windows, curtain walls, storefronts, louvers and doors.

3. Different 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 potential air leakage pathways in the building envelope.

1.6 SUBMITTALS

A. Action Submittals:

1. Product Data: For each type of product.

a. Include manufacturer's written instructions for evaluating, preparing, and treating each substrate; technical data; and tested physical and performance properties of products.

2. Shop Drawings: For air-barrier assemblies.

a. Show locations and extent of air-barrier materials, accessories, and assemblies specific to Project conditions.

b. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.

c. Include details of interfaces with other materials that form part of air barrier.

B. Informational Submittals:

1. Qualification Data: For Installer. Include list of ABAA-certified installers and supervisors employed by Installer, who work on Project.

2. Product Certificates: From air-barrier manufacturer, certifying compatibility of air barriers and accessory materials with Project materials that connect to or that come in contact with air barrier.

3. Product Test Reports: For each air-barrier assembly, for tests performed by a qualified testing agency.

4. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. Qualifications:

1. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

2. Installer shall be licensed by ABAA according to ABAA's Quality Assurance Program and shall employ ABAA-certified installers and supervisors on Project.

B. Pre-Installation Conference: Conduct conference at Project site.

1. Review air-barrier requirements and installation, special details, mockups, air-leakage and bond testing, air-barrier protection, and work scheduling that covers air barriers.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on field mockups.

B. Mockup Testing: Air-barrier assemblies shall comply with performance requirements indicated, as evidenced by reports based on mockup testing by a qualified testing agency.

1. Air-Leakage-Location Testing: Mockups will be tested for evidence of air leakage according to ASTM E1186, chamber pressurization or depressurization with smoke or liquid tracers.

2. Air-Leakage-Volume Testing: Mockups will be tested for air-leakage rate according to ASTM E783.

3. Adhesion Testing: Mockups will be tested for required air-barrier adhesion to substrate according to ASTM D4541.

4. Notify Architect seven days in advance of the dates and times when mockups will be tested.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Remove and replace liquid materials that cannot be applied within their stated shelf life.

B. Protect stored materials from direct sunlight.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended in writing by air-barrier manufacturer.

1. Protect substrates from environmental conditions that affect air-barrier performance.

2. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Source Limitations: Obtain primary air-barrier materials and air-barrier accessories from single source from single manufacturer.

2.2 BITUMINOUS SHEET AIR BARRIER

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Carlisle Coatings & Waterproofing Inc.

2. GCP GCP Applied Technologies Inc.

3. Henry Company.

4. Soprema, Inc.

B. Vapor Impermeable Bituminous Sheet Barrier

1. Vapor-Impermeable Bituminous Sheet: Minimum 40-mil-thick, self-adhering vapor impermeable air barrier membrane.

2. Basis of Design product:

a. Henry Blueskin SA

3. Physical and Performance Properties:

a. Air Permeance: Maximum 0.0002 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. pressure difference; ASTM E2178.

b. Puncture Resistance: Minimum 40 lbf; ASTM E154/E154M.

c. Vapor Permeance: Minimum 0.08 perms; ASTM E96/E96M, Method B.

d. Adhesion to Substrate: Minimum 16 lbf/sq. in. when tested according to ASTM D4541 as modified by ABAA.

e. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.

f. UV Resistance: Can be exposed to sunlight for 60 days according to manufacturer's written instructions.

C. Vapor Permeable Bituminous Sheet Barrier

1. Vapor-Permeable Bituminous Sheet: Minimum 23-mil-thick, self-adhering vapor permeable air barrier membrane.

2. Basis of Design Product:

a. Henry Blueskin VP160

3. Physical and Performance Properties:

a. Air Permeance: Maximum 0.004 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. pressure difference; ASTM E2178.

b. Puncture Resistance: Minimum 40 lbf; ASTM E154/E154M.

c. Vapor Permeance: Minimum 29 perms; ASTM E96/E96M.

d. Adhesion to Substrate: Minimum 16 lbf/sq. in. when tested according to ASTM D4541 as modified by ABAA.

e. UV Resistance: Can be exposed to sunlight for 60 days according to manufacturer's written instructions.

2.3 ACCESSORY MATERIALS

A. Requirement: Provide primers, transition strips, termination strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in writing by air-barrier manufacturer to produce a complete air-barrier assembly and that are compatible with primary air-barrier material and adjacent construction to which they may seal.

B. Primer: Liquid primer recommended for substrate by air-barrier material manufacturer.

C. Stainless-Steel Sheet: ASTM A240/A240M, Type 304, 0.0250 inch thick, and Series 300 stainless-steel fasteners.

D. Preformed Silicone Extrusion: Manufacturer's standard system consisting of cured low-modulus silicone extrusion, sized to fit opening widths, with a single-component, neutral-curing, Class 100/50 (low-modulus) silicone sealant for bonding extrusions to substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.

2. Verify that substrates have cured and aged for minimum time recommended in writing by air-barrier manufacturer.

3. Verify that substrates are visibly dry and free of moisture. Test concrete substrates for capillary moisture by plastic sheet method according to ASTM D4263.

4. Verify that masonry joints are flush and completely filled with mortar.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

A. Clean, prepare, treat, fill, and seal substrate and joints and cracks in substrate according to manufacturer's written instructions and details. Provide clean, dust-free, and dry substrate for air-barrier application.

B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.

C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching membrane.

E. Remove excess mortar from masonry ties, shelf angles, and other obstructions.

F. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.

G. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless-steel sheet mechanically fastened to structural framing to provide continuous support for air barrier.

H. Bridge joints and discontinuous wall-to-wall, deck-to-wall, and deck-to-deck joints with air-barrier accessory material that accommodates joint movement according to manufacturer's written instructions and details.

3.3 INSTALLATION

A. Install materials according to air-barrier manufacturer's written instructions and details to form a seal with adjacent construction and ensure continuity of air and water barrier.

1. Unless manufacturer recommends in writing against priming, apply primer to substrates at required rate and allow it to dry.

B. Prepare, treat, and seal inside and outside corners and vertical and horizontal surfaces at terminations and penetrations with termination mastic.

C. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by air-barrier sheet on same day. Reprime areas exposed for more than 24 hours.

D. Apply and firmly adhere air-barrier sheets over area to receive air barrier. Accurately align sheets and maintain uniform 2-1/2-inch-minimum lap widths and end laps. Overlap and seal seams, and stagger end laps to ensure airtight installation.

1. Apply sheets in a shingled manner to shed water.

2. Roll sheets firmly to enhance adhesion to substrate.

E. Apply continuous air-barrier sheets over accessory strips bridging substrate cracks, construction, and contraction joints.

F. CMU: Install air-barrier sheet horizontally against the CMU beginning at base of wall. Align top edge of air-barrier sheet immediately below protruding masonry ties or joint reinforcement or ties, and firmly adhere in place.

1. Overlap horizontally adjacent sheets a minimum of 2 inches and roll seams.

2. Apply overlapping sheets with bottom edge slit to fit around masonry reinforcing or ties. Roll firmly into place.

3. Seal around masonry reinforcing or ties and penetrations with termination mastic.

4. Continue the sheet into all openings in the wall, such as doors and windows, and terminate at points to maintain an airtight barrier that is not visible from interior.

G. Seal top of through-wall flashings to air-barrier sheet with an additional 6-inch-wide, transition strip.

H. Seal exposed edges of sheet at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.

I. Install air-barrier sheet and accessory materials to form a seal with adjacent construction and to maintain a continuous air barrier.

1. Coordinate air-barrier installation with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.

2. Install transition strip on roofing membrane or base flashing so that a minimum of 3 inches of coverage is achieved over each substrate.

J. Connect and seal exterior wall air-barrier sheet continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.

K. At end of each working day, seal top edge of air-barrier material to substrate with termination mastic.

L. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

M. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply transition strip or preformed silicone extrusion so that a minimum of 3 inches of coverage is achieved over each substrate. Maintain 3 inches of contact over firm bearing to perimeter frames, with not less than 1 inch of full contact.

1. Transition Strip: Roll firmly to enhance adhesion.

2. Preformed Silicone Extrusion: Set in full bed of silicone sealant applied to walls, frame, and air-barrier material.

N. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, doors, and miscellaneous penetrations of air-barrier material with foam sealant.

O. Repair punctures, voids, and deficient lapped seams in air barrier. Slit and flatten fishmouths and blisters. Patch with air-barrier sheet extending 6 inches beyond repaired areas in all directions.

P. Do not cover air barrier until it has been tested and inspected by testing agency.

Q. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

3.4 FIELD QUALITY CONTROL

A. General:

1. ABAA Quality Assurance Program: Perform examinations, preparation, installation, testing, and inspections under ABAA's Quality Assurance Program.

2. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Inspections: Air-barrier materials, accessories, and installation are subject to inspection for compliance with requirements. Inspections may include the following:

1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.

2. Continuous structural support of air-barrier system has been provided.

3. Masonry and concrete surfaces are smooth, clean, and free of cavities, protrusions, and mortar droppings.

4. Site conditions for application temperature and dryness of substrates have been maintained.

5. Maximum exposure time of materials to UV deterioration has not been exceeded.

6. Surfaces have been primed.

7. Laps in sheet materials have complied with the minimum requirements and have been shingled in the correct direction (or mastic applied on exposed edges), with no fishmouths.

8. Termination mastic has been applied on cut edges.

9. Air barrier has been firmly adhered to substrate.

10. Compatible materials have been used.

11. Transitions at changes in direction and structural support at gaps have been provided.

12. Connections between assemblies (air barrier and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.

13. All penetrations have been sealed.

C. Field Tests:

1. Air-Leakage Tests: As determined by testing agency from among the following tests:

a. Air-Leakage-Location Testing: Air-barrier assemblies will be tested for evidence of air leakage according to ASTM E1186, chamber pressurization or depressurization with smoke tracers or detection liquids as recommended by Manufacturer.

b. Air-Leakage-Volume Testing: Air-barrier assemblies will be tested for air-leakage rate according to ASTM E783.

2. Adhesion Testing: Air-barrier assemblies shall be tested for required adhesion to substrate according to ASTM D4541 for each 600 sq. ft. of installed air barrier or part thereof.

3. Air barriers will be considered defective if they do not pass tests and inspections.

   a. Apply additional air-barrier material, according to manufacturer's written instructions, where inspection results indicate insufficient thickness.

   b. Remove and replace deficient air-barrier components for retesting as specified above.

4. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

5. Prepare test and inspection reports.

3.5 CLEANING AND PROTECTION

A. Protect air-barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.

1. Protect air barrier from exposure to UV light and harmful weather exposure as recommended in writing by manufacturer. If exposed to these conditions for longer than recommended, remove and replace air barrier or install additional, full-thickness, air-barrier application after repairing and preparing the overexposed materials according to air-barrier manufacturer's written instructions.

2. Protect air barrier from contact with incompatible materials and sealants not approved by air-barrier manufacturer.

B. Clean spills, stains, and soiling from construction that would be exposed in the completed Work, using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION 072700

SECTION 074213

METAL INSULATED WALL PANEL

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 installation of the Insulated Metal Panel System as indicated on the drawings and/or specified herein, including, but not limited to, the following:

1. Exterior Insulated Metal Panel System at the CFM Building including:

a. Exterior Insulated Metal panels

b. Exterior Rain Screen Finish Panel

c. Exterior Insulated Barrier Wall Panel Accessories

1.3 RELATED SECTIONS

A. Exterior Thermal Insulation – Section 072100

B. Exterior Self-Adhering Sheet Barriers – Section 072700

C. Sheet Metal Flashing – Section 076200

D. Firestops and Smoke Seals – 078413

E. Joint Sealants – Section 079200

F. Metal Framed Windows and Doors – Section 085113

G. Exterior Glass and Glazing – Section 088000

1.4 REFERENCES

A. American Architectural Manufacturers Association (AAMA)

1. AAMA 501.1: Standard Test Method for Metal Curtain Walls for water penetration using Dynamic Pressure.

2. AAMA 501.2: Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls and Sloped Glazing Systems.

B. American Society of Civil Engineers (ASCE)

1. ASCE 7: Minimum Design Loads for Buildings and Other Structures.

C. ASTM International

1. ASTM A480: Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.

2. ASTM A653: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

3. ASTM A755: Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products

4. ASTM A792: Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot–Dip Process

5. ASTM A924: Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process

6. ASTM B117: Standard Practice for Operating Salt Spray (Fog) Apparatus

7. ASTM B209: Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

8. ASTM C209: Standard Test Methods for Cellulosic Fiber Insulating Board

9. ASTM C273: Standard Test Method for Shear Properties of Sandwich Core Materials.

10. ASTM C518: Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus

11. ASTM C920: Standard Specification for Elastomeric Joint Sealants

12. ASTM D224; Standard Specification for Smooth-Surfaced Asphalt Roll

13. ASTM D522: Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings

14. ASTM D523: Standard Test Method for Specular Gloss

15. ASTM D714: Standard Test Method for Evaluating Degree of Blistering of Paints

16. ASTM D968: Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive

17. ASTM D1308: Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes

18. ASTM D1621: Standard Test Method for Compressive Properties of Rigid Cellular Plastics
19. ASTM D1622: Standard Test Method for Apparent Density of Rigid Cellular Plastics
20. ASTM D1623: Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics
21. ASTM D1654: Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.
22. ASTM D1929: Standard Test Method for Determining Ignition Temperature of Plastics
23. ASTM D2126: Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging.
24. ASTM D2244: Standard practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
25. ASTM D2247: Standard Practice for Testing Water Resistance of Coatings in 100 percent Relative Humidity
26. ASTM D2794: Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
27. ASTM D3273: Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
28. ASTM D3359: Standard Test Methods for Measuring Adhesion by Tape Test
29. ASTM D3363: Standard Test Method for Film Hardness by Pencil Test
30. ASTM D4145: Standard Test Method for Coating Flexibility of Prepainted Sheet
31. ASTM D4214: Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films
32. ASTM D5894: Standard Practice for Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV Condensation Cabinet)
33. ASTM D6226: Standard Test Method for Open Cell Content of Rigid Cellular Plastics.
34. ASTM E72: Standard Test Methods of Conducting Strength Tests of Panels for Building Construction
35. ASTM E84: Standard Test Method for Surface Burning Characteristics of Building Materials
36. ASTM E90: Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
37. ASTM E283: Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
38. ASTM E330: Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference

39. ASTM E331: Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference

40. ASTM G153: Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

41. ASTM G154: Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials

D. FM Global (FM)

1. Approval Standard 4880; Class 1 Fire Rating of Insulated Wall or Wall and Roof/Ceiling Panels, Interior Finish Materials or Coatings, and Exterior Wall Systems.

2. Approval Standard 4881; Class 1 Exterior Wall Systems.

E. International Building Code (IBC): current edition

1. National Fire Protection Agency (NFPA)

2. NFPA 259: Standard Test Method for Potential Heat of Building Materials.

3. NFPA 268: Standard Test Method for Determining Ignitibility of Exterior Wall Assemblies Using a Radiant Heat Energy Source.

4. NFPA 285: Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components.

F. International Organization for Standardization (ISO)

1. ISO 14025: Environmental Labels and Declarations

1.5 ADMINISTRATIVE REQUIREMENTS

A. Pre-installation meeting: Conduct a pre-installation meeting at the job site attended by Owner, Architect, Manufacturer's Technical Representative, Panel Installer, and Contractors of related trades. Coordinate structural support requirements in relation to insulated wall panel system, installation of any separate air/water barriers, treatment of fenestration, and other requirements specific to the project.

1.6 SYSTEM DESCRIPTION

A. Insulated-Core Metal Wall Backup Panel System: Metal wall backup panel installation consisting of foamed-insulation-core metal-skinned wall panels and accessories, attached to metal framing with specified clips, serving as combined thermal, air, and moisture barrier and support for metal wall panel rain screen cladding and FRC veneer.

1.7 PERFORMANCE CRITERIA:

A. Structural Test: Structural performance shall be verifiable by witnessed structural testing for simulated wind loads in accordance with ASTM E72 and E330. Deflection criteria shall be [L/180].

B. Fatigue Test: There shall be no evidence of metal/insulation interface delamination when the panel is tested by simulated wind loads (positive and negative loads), when applied for two million alternate cycles of L/180 deflection.

C. Freeze / Heat Cycling Test: Panels shall exhibit no delamination, surface blisters, permanent bowing or deformation when subjected to cyclic temperature extremes of minus 36 deg. F to plus 180 deg. F temperatures for twenty one, eight-hour cycles.

D. Water Penetration: There shall be no uncontrolled water penetration through the panel joints at a pressure differential of 20 psf, when tested in accordance with ASTM E331.

E. Dynamic Water Penetration: There shall be no uncontrolled water penetration through the panel assembly at a pressure difference of 15 psf, when tested in accordance with AAMA 501.1.

F. Air Infiltration: Air infiltration through the panel shall not exceed 0.01 cfm/sf at 20 psf air pressure differential when tested in accordance with ASTM E283.

G. Humidity Test: Panels shall exhibit no delamination or metal interface corrosion when subjected to plus 140 deg. F temperature and 100 percent relative humidity for a total of 1200 hours (50 days).

H. Autoclave Test: Panels shall exhibit no delamination or shrinkage/melting of the foam core from the metal skins after being subjected in an autoclave to a pressure of 2psig (13.8kPa) at a temperature of plus 218 deg. F (plus 103 deg. C) for a period of 2 1/2 hours.

I. Seismic Performance: Comply with ASCE 7, Section 13, “Seismic Design Requirements for Non-Structural Components”. Panels shall be hard-fastened to structure along one edge only such that lateral slippage between panels can occur in the event of seismic activity.

J. Energy Performance: Certified by contractor for energy performance as follow:
   1. Thermal Transmittance (U-Factor): U-factor for the system of not more than 0.312 Btu/sq. ft. x h x deg F

K. Panel Fire Tests:

   1. Fire Endurance Test – 10 minutes: Panels remained in place without joint stitch fastening per CAN/ULC-S101.

L. Flame Spread and Smoke Developed Tests on exposed Insulating Core:

   1. Flame Spread: 25 or less.

   2. Smoke Developed: 50 or less.

   3. Tests performed in accordance with CAN/ULC-S102 and ASTM E84.

M. Fire Test Response Characteristics: Steel-faced panels with QuadCore polyisocyanurate (POLYISO) core shall fully comply with Chapter 26 of International Building Code regarding the use of Foam

Plastic. The following tests shall be available upon request for submission to the Authority Having Jurisdiction:

1. NFPA 259 Potential Heat Content; established for foam core.

2. NFPA 285 Intermediate Scale Multi-story Fire Evaluation; successfully passed acceptance criteria.

3. UL 263 Fire Resistive Rating; classified as a component of a fire-rated wall assembly for 1-hour and 2-hour rating Design No. U053 (rated assemblies include appropriate layers of fire-rated Type X Gypsum board).

4. ASTM D1929 Minimum Flash and Self Ignition; established for foam core.

5. S101, S102, S127, S134 UL Canada fire test standards; successfully passed.

N. Insulating Core: QuadCore polyisocyanurate (POLYISO) foamed-in-place core, ASTM C591 Type IV, CFC and HCFC free, Halogenated Flame Retardant (HFR) free, compliant with Montreal Protocol and Clean Air Act, with the following minimum physical properties:

1. Core is 90 percent closed cell when tested in accordance with ASTM D6226

2. Panel shall provide a nominal R-value of 8.0 [hr·ft2·°F/Btu] per inch thickness when tested in accordance with ASTM C 518 at 75°F mean temperature and 9.0 [hr·ft2·°F/Btu] per inch thickness when tested in accordance with ASTM C 518 at 35°F mean temperature.

3. Foam has a density of 2.2 to 2.8 pounds per cubic foot when tested in accordance with ASTM D1622

4. Compressive Stress: Panels shall have a compressive stress of 24 psi. when tested according to ASTM D1621

5. Shear Stress: 17 psi when tested in accordance with ASTM C273

6. Tensile Stress:19 psi when tested in accordance with ASTM D1623

7. Oven Aging at 212 degrees F

   a. 1 day: Minus 0.63 percent volume change

   b. 7 days: Plus 0.43 percent volume change

   c. Tested according to ASTM D2126

8. Low Temperature Aging at minus 40 degrees F:

   a. 1 day: Plus 0.16 percent volume change

   b. 7 days: Minus 0.60 percent volume change

   c. Tested according to ASTM D2126

1.8 SUBMITTALS

A. Product Data: Submit manufacturer current technical literature for each type of product.

B. Shop Drawings: Submit detailed drawings and panel analysis stamped and sealed by a New York State licensed Professional Engineer showing:

1. Profile
2. Gauge of both exterior and interior sheet
3. Location, layout and dimensions of panels
4. Location and type of fasteners
5. Shape and method of attachment of all trim
6. Locations and type of sealants
7. Installation sequence
8. Coordination Drawings: Provide elevation drawings and building sections which show panels in relationship to required locations for structural support. Include panel details and details showing attachment to structural support.
9. Other details as may be required for a weathertight installation

C. Calculations: Structural calculations signed and sealed by a professional engineered in the State of New York.

1. Panel Analysis: Provide panel calculations to verify panels will withstand the design wind loads indicated without detrimental effects or deflection exceeding L/180. Include effects of thermal differential between the exterior and interior panel facings and resistance to fastener pullout.

D. Samples: Provide nominal 12x12 inch of each color indicated. Provide panel width by 12 inches long minimum.

E. Miscellaneous Certifications:

1. Submit documentation that products have been certified in accordance with ISO 14025.

F. Quality Assurance Submittals

1. Design Data, Test Reports: Provide manufacturer test reports indicating product compliance with requirements.
2. Manufacturer Erection Instructions: Provide manufacturer's written installation instructions including proper material storage, material handling, installation sequence, panel location(s), and attachment methods, details and required trim and accessories.

1.9 QUALITY ASSURANCE

A. Manufacturer Qualifications:

B. Manufacturer shall have a minimum of five (5) years experience in the production of insulated wall panels. Manufacturer shall demonstrate past experience with examples of projects of similar type and exposure.

C. Manufacturer to be registered with a Program Operator with a Certified, Environmental Product Declaration, in conformance with ISO 14025, for Insulated Metal Panels.

D. Installer Qualifications: Authorized by the manufacturer and the work shall be supervised by a person having a minimum of five (5) years experience installing insulated wall panels on similar type and size projects.

1.10 DELIVERY, STORAGE AND HANDLING

A. Deliver panel materials and components in manufacturer's original, unopened, undamaged packaging with identification labels intact.

B. Store wall panel materials on dry, level, firm, and clean surface. Stack no more than two bundles high. Elevate one end of bundle to allow moisture run-off, cover and ventilate to allow air to circulate and moisture to escape.

1.11 WARRANTY

A. Limited Warranty: Standard form in which manufacturer agrees to repair or replace items that fail in materials or workmanship within specified warranty period. The items covered by the warranty include structural performance including bond integrity, deflection and buckling.

B. Warranty Period: Two (2) years from date of Substantial Completion, or 2 years and 6 months from the date of shipment from manufacturer's plant, whichever occurs first.

C. Finish Warranty: Standard form in which manufacturer agrees to repair or replace metal panels that evidence deterioration of fluoropolymer finish, including flaking or peeling from approved primed metal substrate, chalk in excess of 8 when tested in accordance with ASTM D4214, Method A, and /or color fading in excess of 5 ΔE Hunter units on panels when tested in accordance with ASTM D2244.

D. Warranty Period: Twenty (20) years from date of Substantial Completion, or 20 years and 3 months from the date of shipment from manufacturer's plant, whichever occurs first.

PART 2 - PRODUCTS

2.1 INSULATED WALL PANELS

A. Manufacturer: Basis of design, Kingspan or comparable.

1. Centria.

2. MetlSpan.

B. Basis of Design Product: Kingspan Karrier Panel.

C. Panel Thickness: As required to meet specified performance but not less than 4 inches thick.

D. Panel Width: 36 inches.

E. Panel Lengths: Longest practical lengths and as approved by Architect.

F. Panel Attachment: Shall consist of fasteners and stainless steel attachment clip completely concealed within the panel side joint.

G. Horizontal Panel Joint Reveals: 3/8 inch.

H. Vertical Joint Treatment: Fill joint with Spray Foam per manufacturer's instructions.

I. Vertical Panel Joint Reveals: 3/8 inch.

J. Exterior and Interior Face of Panel:

1. Material:

a. Steel coil material shall be in accordance with ASTM A755: AZ50 Galvalume/Zincalume (55 percent aluminum, 45 percent zinc) in accordance with ASTM A792.

b. Gauge: 22 gauge or as approved by Architect.

2. Profile: Shadowline.

3. Exterior Finish System:

a. Exterior Finish: 1.0 mil. Fluropolymer (PVDF) Two Coat system: 0.2 mil primer with 0.8 mil Kynar 500 (70 percent) SOLID color coat.

b. Finish Color: Architect to select from current selected manufacturer's color chart.

4. Interior Finish System:

a. Interior Finish: PVDF finish, dry film thickness of 1.0 mil including primer.

b. Finish Color: Architect to select from current selected manufacturer's color chart.

2.2 INSULATED BARRIER WALL PANEL ACCESSORIES

A. Fasteners: Corrosion-resistant, self-tapping and self-drilling screws, bolts, nuts, and other fasteners as recommended by panel manufacturer for application.

1. Self-drilling fasteners shall be cadmium plated steel with neoprene washer as recommended by manufacturer.

2. Material: Hex-head type with steel and neoprene washer and 12-gauge stainless steel clip supplied by the manufacturer.

3. Size: Size fasteners to prevent penetration of interior panel facing.

B. Subgirts: Metallic-coated steel sheet, ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality, 0.054-inch/16-gage thick.

C. Karrier Rails: Metallic-coated steel sheet, ASTM A 653/A 653M, G90 (Z275) coating designation, of thickness indicated, configured to serve as attachment points for secondary metal framing where indicated, manufacturer-furnished.

D. Self-Adhering Sheet Flashing: Minimum 25-mil modified bituminous sheet, recommended by panel manufacturer for application.

E. Perimeter Trim: Fabricated perimeter trim shall be same gauge, material and coating color as exterior face of insulated barrier wall panel.

F. Joint Sealants:

1. Concealed: Non-skinning butyl sealant, AAMA 809.2.

2. Exposed: Elastomeric silicone sealant, ASTM C 920, as recommended by panel manufacturer.

2.3 EXTERIOR RAINSCREEN FINISH PANEL

A. Manufacturer: Basis of design, CBS Sheetmetal or comparable.

1. Kenneth J Herman, Inc.

2. Kingspan

3. PacClad

B. Basis of Design Product: “B-Deck” corrugated metal panel.

C. Profile: “B-Deck” or “Wide Rib” 6-inch corrugation O.C. 3.5 inch high-cell width.

D. Panel Lengths: Longest practical lengths and as approved by Architect.

E. Profile Orientation: Vertical

F. Material: Galvalume-Coated Steel

1. Finish: 1.0 mil Fluropolymer (PVDF) Two Coat system: 0.2 mil primer with 0.8 mil MICA fluoropon classic II PVDF or metallic fluoropon classic PVDF as selected by Architect.

2. Color: As selected by the Architect from manufacturer's full range of colors.

G. Accessories:

1. Fasteners: Sufficient length to provide solid attachment through to structure as required by manufacturer.

a. Self-drill hex-washer-head stainless steel with 1,000 hour salt-spray rated thermoset polyester coating.

b. Embedment depth: 0.625 inches or three full threads minimum, whichever is greater.

2. Metal Profile Closure Strips and Trims: Extruded aluminum as indicated on the Drawings finished to match siding.

3. Locations include, but are not limited to the following: Drips, sills, jambs, corners, framed openings, parapet caps, reveals and fillers.

2.4 FABRICATION

A. Insulated metal panel

1. General: Fabricate metal wall backup panels at the factory, using manufacturer's standard procedures and processes identical to tested units and as necessary to meet performance requirements.

a. Fabricate metal wall backup panels with joints between panels designed to form weathertight seals.

b. Factory form metal wall backup panels in a continuous process with no glues or adhesives between dissimilar materials. Trim and square edges of sheets with no displacement of face sheets or protrusion of core material.

B. Exterior rain screen metal panel

1. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

2.5 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

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 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.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine building structure with Installer present. Inspect for erection tolerances and other conditions that would adversely affect installation.

B. Supporting Steel: All structural supports required for installation of panels shall be by others. Support members shall be installed within the following tolerances;

1. Plus or minus 1/8 inch in 5 feet in any direction along the plane of framing.

2. Plus or minus 1/4 inch cumulative in 20 feet in any direction along the plane of framing.

3. Plus or minus 1/2 inch from the framing plane on any elevation.

4. Plumb or level within 1/8 inch at all changes of transverse for pre-formed corner panel applications.

5. Verify that bearing support has been provided behind vertical joints of horizontal panel systems and horizontal joints of vertical panel systems. Width of support shall be as recommended by manufacturer.

C. Framing: Inspect framing that will support metal wall backup panel system to determine if support components are installed as indicated on approved shop drawings.

D. Advise G.C, in writing, of out-of-tolerance work and other deficient conditions prior to proceeding with metal wall panel system installation.

E. Correct out of tolerance work and other deficient conditions prior to proceeding with insulated composite backup panel installation.

3.2 INSULATED METAL PANEL INSTALLATION

A. Installation shall be in accordance with manufacturer’s installation guidelines and recommendations.

B. Install panels plumb, level, and true-to-line to dimensions and layout indicated on approved shop drawings.

C. Cut panels prior to installing, where indicated on shop drawings, using a power circular saw with fine tooth carbide tip blade per manufacturer’s instructions.

D. Butyl Weather Barrier Sealant:

1. Apply non-skinning butyl sealant as shown on shop drawings and manufacturer’s installation instructions as necessary to establish the vapor barrier for the panels.

2. Use non-skinning butyl tube sealant only for tight metal-to-metal contact.

3. Do not use non-skinning butyl tube sealant to bridge gaps.

E. Place panel fasteners through pre-punched holes in attachment clips. Location of hat channel attachment clips to be aligned to the vertical façade grids diagrammed in the Architectural Drawings (Setting-out Drawings). Secure units to the structural supports. Space clips as recommended by manufacturer or otherwise indicated on the Architectural Drawings.

F. Fire separation to be provided at slab edges to meet requirements by Kingspan.

1. Void between the back of rainscreen cladding and face of insulated metal panel to be completely filled with min. 4 PSI continuous fire blocking at max 20 feet o.c. spacing.

3.3 RAINSCREEN METAL PANEL INSTALLATION

A. Installation shall be in accordance with manufacturer's installation guidelines and recommendations.

1. Shim or otherwise plumb sub framing receiving metal panels.

2. Locate and space fastenings in uniform vertical and horizontal alignment.

a. Horizontal: 6 inch O.C., centered within the low-cell of the corrugation. See Architectural Drawings.

b. Vertical: 36 inch O.C., aligned to the Vertical Façade Grids. See Architectural Drawings.

3. Midpoint of corrugation high cells to align to the centerline of grids and sub-grids. See Architectural Drawings.

4. Align bottoms of metal panels.

B. Install panels plumb, level, and true-to-line to dimensions and layout indicated on approved shop drawings.

C. Cut panels prior to installing, where indicated on shop drawings, using a power circular saw with fine tooth carbide tip blade per manufacturer's instructions. Personnel should wear respiratory and eye protection devices.

D. Use stainless steel fasteners for surfaces exposed to the exterior.

E. Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

3.4 FLASHING AND TRIM

A. General

1. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.

2. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof performance.

3. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently

waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

B. Trim Installation

1. Place trim and trim fasteners only as indicated per details on the approved shop drawings.

2. Field drill weep holes where appropriate in horizontal trim; minimum 1/4 inch diameter at 24 inches on center.

3. Place a continuous strip of butyl tube sealant between the inside back face of closure trims and interior panel faces for proper vapor seal.

3.5 SEALANT INSTALLATION FOR EXPOSED JOINTS

A. Clean and prime surfaces to receive exterior exposed sealants in accordance with sealant manufacturer's recommendations.

B. Follow sealant manufacturer's recommendations for joint width-to-depth ratio, application temperature range, size and type of backer rod, and compatibility of materials for adhesion.

C. Direct contact between butyl and silicone sealants shall not be permitted.

3.6 ERECTION TOLERANCES

A. Installation Tolerances: Align metal wall backup panel system within installed tolerance of 1/4 inch in 20 feet, noncumulative, on level and plumb and location lines as indicated and within 1/8 inch offset of adjoining faces and of alignment of matching profiles.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: General Contractor shall engage an independent testing and inspection agency acceptable to the architect to perform field tests and inspections and to prepare reports of findings.

B. Field Water Test: After completing portion of metal wall panel assembly including accessories and trim, test a 2-bay area selected by the architect for water penetration in accordance with AAMA 501.2.

3.8 CLEANING AND PROTECTION

A. Remove protective film immediately after installation.

B. Touch-up, repair or replace metal panels and trim that have been damaged.

C. After metal wall panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

END OF SECTION 074213

SECTION 075400

THERMOPLASTIC (TPO) MEMBRANE 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 and roof insulation as shown on the drawings and specified herein, including, but not limited to, the following:

1. Fully-adhered TPO membrane roofing and insulation system.
2. Cover board and roof insulation below membrane.
3. Vapor retarder.
4. Membrane flashing and accessories.

1.3 RELATED SECTIONS

A. Carpentry - Section 062000, for wood blocking.

B. Sheet Metal Flashing - Section 076200.

C. Plumbing - Division 22, for drains and vents.

1.4 DEFINITIONS

A. Roofing Terminology: Refer to ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.

1.5 QUALITY ASSURANCE

A. General: Provide installed roofing membrane and base flashings that remain watertight; do not permit the passage of water; and resist specified uplift pressures, thermally induced movement, and exposure to weather without failure.

B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by roofing membrane manufacturer based on testing and field experience.

C. 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.

D. UL Listing: Provide labeled materials which have been tested and listed by UL for application indicated and which have a Class A rating.

E. Roofing System Design: Provide membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.

F. Provide an installed roofing membrane and base flashing sysetm that does not permit the passage of water, and will withstand the design pressures determined in FM Global Loss Prevention Data Sheet 1-28, to meet a 1-90 or greater wind uplift rating as required by location.

G. Membrane roofing system shall be ENERGY STAR compliant (highly reflective SRI 78) and high emissivity roofing (emissivity of at least 0.9 when tested in accordance with ASTM E 408).

H. Roofing shall have a Solar Reflectance index (SRI) of 78 or above.

1.6 SUBMITTALS

A. Submit complete shop drawings showing details, dimensions, colors, fabrication and fastening elements for each condition encountered, 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.

B. Submit notarized letter indicating that roofing Subcontractor is an approved applicator of the manufacturer.

C. Submit a letter signed by the manufacturer and Contractor acknowledging that the submitted roofing system complies with ASCE-7 and FM 1-90, for wind speed code requirements based on height and geographic location of project.

1.7 PREROOFING CONFERENCE

A. Prior to ordering of materials, a preroofing conference will be held to discuss the specified roofing system, and its proper application. Conference shall include installer, 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.

1.8 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 other suitable watertight covering. Store and handle in such a way as to prevent damage to edges or ends.

1.9 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. and falling or if there is a forecast for inclement weather which will adversely affect 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.

1.10 WARRANTY

A. Provide 20 years (NDL) from date of substantial completion system warranty 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. 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 TPO SHEET ROOFING MEMBRANE

A. Basis of Design: Provide "EverGuard TPO" fully-adhered system as manufactured by GAF, or an approved equal acceptable to the Architect.

B. Fabric-Reinforced TPO Sheet: ASTM D 6878, internally fabric- or scrim-reinforced, uniform, flexible TPO sheet.

1. Thickness: 80 mils.

2. Exposed Face Color: White.

2.2 ACCESSORY MATERIALS

A. Membrane Flashing: Manufacturer’s standard unreinforced thermoplastic-polyolefin sheet flashing, 60 mils thick minimum, of same color as membrane.

B. Bonding Adhesives, Mastics and Splicing Cement: Compatible with the materials with which they will come in contact; solvent based.

C. Lap Sealant: For sealing the exposed edge of the splices and as otherwise required shall be of a consistency recommended by the manufacturer.

D. Prefabricated Pipe Seal Assemblies: Provide assemblies to accommodate vents, pipe penetrations and other similar roof penetrations.

E. Sealers: Provide sealers and other similar accessory materials as recommended by the manufacturer.

F. Materials: The materials provided shall be part of a roofing system developed by the approved manufacturer and shall in every respect be compatible with each other and with the substrates and conditions encountered in the field.

G. Cant Strips, Tapered Edge Strips, and Flashing Accessories: Types recommended by membrane manufacturer, including adhesive tapes, flashing cements, and sealants.

H. Membrane Adhesive: As recommended by membrane manufacturer for particular substrate and project conditions, formulated to withstand ASCE 7-98 and FM 1-60 wind uplift force requirements of the geographic area of the building.

1. Provide adhesives that comply with local requirements limiting amounts of volatile organic compounds.

I. Roof Insulation: Two layers of 2" minimum thick flat and tapered (1/8" per foot) polyisocyanurate board roof insulation conforming to ASTM C 1289, Type II, faced with proper facing to allow membrane to be adhered to it without delamination. Roof insulation must have an LTTR R-Value of 5.7/inch at 75 deg. F. when tested in accordance with ASTM C 1303.

1. Basis of Design: GAF "EnergyGuard Polyiso" and "EnergyGuard Tapered Polyiso," or approved equal.

J. Cover Board: 1/2” thick Georgia Pacific "Dens-Deck Roof Board," ASTM C 1177, glass-mat, water-resistant gypsum substrate; thickness as indicated.

K. Walkways: Provide non-skid walkway pads in areas of heavy foot traffic and around mechanical equipment. Walkway pads must be as manufactured by roof membrane manufacturer.

L. Decorative Ballast: As selected by the Architect.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where roofing 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. Nailers

1. Continuous pressure treated nailers shall be firmly anchored to resist a force of 75 pounds per lineal foot in any direction. The thickness of the nailer shall be such that the top of the nailer is flush with the surface to which the membrane is attached at the horizontal plane.

2. Nailers shall be installed continuous at perimeters and around all roof penetrations unless otherwise noted.

B. Insulation

1. Clean the deck prior to installing the insulation. Mechanically attach insulation to deck using FM approved fasteners in pattern to meet FM 1-90 minimum (unless greater required by ASCE) and ASCE 7-98 wind uplift requirements, including greater requirements for corners and perimeters as required. For tapered insulation, follow pattern of taper to insure correct pitch.

2. Moderately butt end joints over flutes, stagger joints in adjacent boards. Do not install more insulation in any one day than can be covered by the membrane roof sheets.

3. Where two layers of insulation and two layers cover boards are required, stagger joints 2 feet in length and width in both directions.

4. Neatly cut around all projections encountered and at abutting vertical surfaces. Where large gaps occur fill with a urethane foam pack.

C. Cover Board: Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6" in each direction. Loosely butt cover boards together and adhere to substrate using two-part urethane adhesive according to roofing system manufacturer's instructions.

D. Sheet Membrane Application (Fully Adhered): Where required by manufacturer, install membrane by unrolling over prepared substrate, lapping adjoining sheets. Apply adhesive to surfaces to be bonded and roll into place when adhesive has properly cured. Treat seams with cleaner and prime finish with 4” seam tape and apply sealant to exposed sheet edges, tapering application as recommended by manufacturer. Install mechanical fasteners, flashings and counterflashings, and accessories at locations and as recommended by manufacturer.

E. Splicing

1. Fold the top sheet back about 12" and clean both mating surfaces at the splice area using clean rags with membrane manufacturer's recommended cleaner.

2. Apply the inseam tape primer with a synthetic scrub pad at a rate of 375 lineal feet of 5" splice per gallon. Allow tape primer to dry to the touch.

3. Roll the top sheet toward the splice area until the cemented area is nearly touching the cement on the bottom sheet along the entire length of the splice. Allow the top sheet to fall freely into place avoiding stretching and wrinkling. Roll the splice with a 2" wide steel roller, using positive pressure, toward the outer edge of the splice.

4. Solvent clean the splice edge, extending at least 1" onto the top and bottom membranes. Apply a bead of lap sealant completely covering the splice edge, feathering the lap sealant with a preformed putty knife or trowel.

5. Lap sealant application shall be completed on all splices by the end of each working day.

F. Membrane Flashing

1. Perimeter flashing and flashing around vents and other roof penetrations shall be preformed using the recommended flashing, compatible with the approved roofing system and utilizing the longest pieces practicable.

2. The splice between the flashing and the main roof sheet should be completed before bonding the flashing to the vertical surface. Seal this splice at least 3" beyond the fasteners which attach the membrane to the horizontal nailer.

3. Bonding adhesive shall be applied to both the flashing and the surface to which it is being bonded. After the adhesive has dried to the point where it does not string or stick to a dry finger touch, roll the flashing into the adhesive. Take care to assure that the flashing is not bridging where there is any change of direction of the flashing (e.g., where the parapet meets the roof deck).

4. Nail the flashing at the top every 12" on center maximum under metal counterflashing or cap. Metal counter is specified under Section 076200.

G. Pipe Flashing

1. Flashing for pipes, conduits and other similar items which are scheduled to penetrate (pass through) the membrane shall be provided with factory prefabricated elements when such use is possible. When prefabricated devices are not possible field fabricated seals shall be used.

2. Bases of the pipe seals shall be spliced to the membrane roofing sheet as specified above for sheet laps and the top portion shall be secured to the pipe with a stainless steel clamping ring and continuously sealed with sealant in a watertight manner.

3. Field fabricated pipe seals shall be fabricated with base and cap membrane flashing which shall be spliced to the membrane and to itself and continuously sealed with sealant in a watertight manner.

H. Drains: At drain locations, where the insulation is tapered to form a smooth transition from roof surface to membrane, the membrane sheet shall be accurately cut-out so as to fit the encountered clamping ring, and shall be secured to the ring with the addition of the approved mastic in a secure, neat and watertight manner.

I. Curbs, Corners

1. Field fabricated outside corners shall consist of approved membrane flashing which shall have not less than 6" horizontal legs which shall be spliced to the roof membrane and vertical legs as required which shall be nailed at 12" o.c. maximum. Corners shall be lapped a minimum of 3" and be secured by splicing to each flashing section

2. Field fabricated inside corners shall consist of approved membrane flashing with 6" horizontal legs which shall be spliced to the roof membrane, with vertical legs as required which shall be nailed at 12" o.c. maximum. Corners shall be lapped a minimum 6" and secured by splicing to each flashing section.

3. Install lap type sealant along all seams to insure a watertight installation.

J. Daily Seal: Care should be exercised to ensure that the water does not flow beneath any completed sections of roof. Temporarily seal loose edge of membrane with sealant when weather is threatening.

1. Mix the two components thoroughly according to the instructions on the label.

2. Apply the sealant at a rate of 100 lineal feet per gallon, (on smooth surface) 12" back from edge of sheet onto exposed substrate surface. If necessary, use a trowel to spread material in order to achieve complete seal.

3. After embedding membrane in sealant, check for continuous contact. Then weight the edge, providing continuous pressure over the length of the cutoff. The recommended weight for the continuous pressure is a 10-foot length of 2-1/2" tubing filled with dry sand.

4. When work is resumed, pull sheet free before continuing installation.

3.3 WALKWAY INSTALLATION

A. Walkways: Install walkway products in locations indicated. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

1. Provide walkways where indicated on the Drawings.

2. Install at roof hatches, access doors, rooftop ladders and all other traffic concentration points regardless of traffic frequency. Provided in areas receiving regular traffic to service rooftop units or where a passageway over the surface is required.

3. Do not install walkways over flashings or fields seams until field inspections by roof membrane manufacturer have been completed.

3.4 CLEANING AND PROTECTION

A. From time to time during the progress of the work and at the completion of the work, remove all rubbish, debris, dirt, equipment and unused materials from the site. Clean adjoining surfaces which may have been soiled by roofing work.

B. Protect installed roofing from damage and abuse by other trades. Repair damages to watertight conditions at no additional cost to the Owner.

C. Exercise care to protect installed work. Work which does become damaged in any way or is not watertight, shall be repaired and/or replaced as directed to the satisfaction of Architect and/or Owner at no additional cost or time.

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 through-wall flashing.
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. Roofing - Division 7.

C. Roof speciaties and accessories – Section 077100.

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. Through-wall flashing shall have sawtooth ribs at three (3) inch intervals, as manufactured by Keystone Flashing Co., or approved equal.

3. Accessories and Fastenings: AISI, Types 302 and 304 stainless steel.

4. 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.

5. 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. Through-Wall Flashings: Provide through-wall flashings as shown. Form bonding features so as not to puddle water on surface. Lap cross joints to interlock design pattern at least three (3) inches. Stop typical flashings in mortar joint 1/2" from exterior face of wall.

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 gravel stops and copings.
2. Through wall overflow scuppers.
3. Roof hatches.
4. Roof smoke vents.
5. Prefabricated roof curbs.

1.3 RELATED SECTIONS

A. Roofing - Section 075419.

B. Sheet Metal Flashing - Section 076200.

C. Metal Framed Skylights - Section 086300.

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 GRAVEL STOPS AND 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. For gravel stops, provide concealed anchors and hold down clips 24" o.c.

E. For copings, provide galvanized steel anchor plates, anchors spaced 6'-0" o.c. and snap-lock coping design; all anchors concealed.

F. 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.

G. Provide units manufactured by OMG Roofing, or equal made by Cheney, Johns Manville or approved equal.

2.2 ROOF HATCH

A. Provide thermally broken shop-primed, galvanized steel roof hatch units of sizes shown on drawings, with 1" 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. Provide units manufactured by Bilco, Babcock-Davis, Milcor or approved equal.

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 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 Wood Curtain Walls - Section 084411.

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 136 "Standard Test Method for Assessing Combustibility of Materials."

D. UL 263, UBC 7-1 "Fire Tests of Building Construction and Materials"

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 safing insulation; Thermafiber Safing Mineral Wool Insulation by Thermafiber, Inc. (an Owens Corning company), Roxul Safe Fire Safing Insulation by Rockwool, Mineral Wool Safing by Johns Manville or approved equal to suit conditions and to comply with fire resistance and firestop manufacturer's requirements.

B. Material shall be classified non-combustible when tested per ASTM E 136.

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. Exterior wall joints not specified to be sealed in other Sections of work.
2. 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.
3. Control and expansion joints in walls.
4. Joints at wall penetrations.
5. Joints between items of equipment and other construction.
6. 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 curtain walls - Section 084411.

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 the warranty 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, 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.

3.3 FIELD QUALITY CONTROL

A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:

1. Extent of Testing: Test completed and cured sealant joints as follows:

    a. Perform 5 tests for the first 1000 feet of joint length for each kind of sealant and joint substrate.
    b. Perform one test for each 5,000 feet of joint length thereafter or one test per each floor per elevation.

2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.

    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.

3. Inspect tested joints and report on the following:

    a. Whether sealants filled joint cavities and are free of voids.
    b. Whether sealant dimensions and configurations comply with specified requirements.
    c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.

4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.

5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

B. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

END OF SECTION

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.

B. Fire rated expansion joint cover assemblies where required.

1.3 RELATED SECTIONS

A. Selective demolition and alteration work - Section 024119.

B. Concrete - Section 033000.

C. Masonry work - Section 042000.

D. Roofing - Division 7.

E. 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 MM Systems Corporation unless otherwise noted; subject to compliance with requirements specified, other acceptable manufacturers include:

1. Emseal

2. Balco/Metalines

3. Watson Bowman Acme

4. Construction Specialties

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.

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.

1. Where cutting into existing construction, conform to the requirements of Section 024119.

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. Preparation of metal doors and frames to receive finish hardware, including reinforcements, drilling and tapping, as necessary.

3. Preparation of hollow metal doors to receive glazing where required.

4. Steel louvers for hollow metal doors.

5. Furnishing anchors for building into masonry and drywall.

6. Factory prime painting of work of this Section.

1.3 RELATED SECTIONS

A. Unit Masonry - Section 042000.

B. Carpentry - Section 062000, for installation of doors and frames.

C. Exterior insulated metal panel – Section 074213.

D. Exterior rainscreen systems – Section 074450.

E. Exterior wood cladding – Section 074623.

F. Wood Doors - Section 081416.

G. Finish Hardware - Section 087100.

H. Glass and Glazing - Section 088000.

I. Gypsum Drywall - Section 092900.

J. Painting and Finishing - Section 099000.

1.4 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. Smoke-Control Door Assemblies: Comply with NFPA 105 or UL 1784.

F. 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.

1.5 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.

1.6 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.

B. Exterior Doors and Frames

1. Basis of Design: Energy Efficient - 797 Mercury Series by Curries or approved equal.

2. Basis of Design: Curries Company (CU) - Thermal Break TQ Series.

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. Thermal-Break Frames: Frames shall be subject to the same compliance standards and requirements as standard hollow metal frames. Frames shall be tested for thermal performance in accordance with NFRC 102 and resistance to air infiltration in accordance with NFRC 400. Where indicated, provide thermally broken frame profiles available for use in both masonry and drywall construction. Fabricate with 1/16" positive thermal break and integral vinyl weather stripping.

3. 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.

4. 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.

5. 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.

6. Minimum depth of stops shall be 5/8".

7. 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.

8. 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 (Contractor shall provide larger and thicker plates as required to accommodate weight of door):
      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.

9. 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.

10. Jamb Anchors

    a. Frames for installation in masonry walls shall be provided with adjustable jamb anchors of the wire type. Anchors shall be not less than 0.156" diameter steel wire. The number of anchors provided on each jamb shall be as follows:
       1). Frames up to 7'-6" height - three (3) anchors.
       2). Frames 7'-6" to 8'-0" height - four (4) anchors.
       3). Frames over 8'-0" height - one (1) anchor for each 2'-0" or fraction thereof in height.

    b. 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:
       1). Frames up to 7'-6" height - four (4) anchors.
       2). Frames 7'-6" to 8'-0" height - five (5) anchors.
       3). Frames over 8'-0" height - five (5) anchors plus one additional for each 2'-0" or fraction thereof over 8'-0".

11. Anchors in exterior frames and in masonry walls shall be hot dip galvanized per ASTM A 153.

12. Frames for installation in masonry wall openings more than 4'-0" in width shall have an angle or channel stiffener factory welded into the head. Such stiffeners shall be not less than twelve (12) gauge steel and not longer than the opening width. Stiffeners shall not be used as lintels or load bearing members.

13. Dust cover boxes (or mortar guards) of not thinner than twenty-six (26) gauge steel shall be provided at all hardware mortises on frames to be set in masonry or plaster partitions.

14. Ceiling Struts: Minimum 3/8" thick x 2" wide steel.

15. 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.

16. 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.

17. 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.

1. Frames set in masonry walls shall be grouted in as described in Section 042000, "Unit Masonry." These frames shall have surfaces in contact with grout shop coated with epoxy coating equal to Series 27 FC Typoxy made by Tnemec or approved equal spray applied at 4 to 6 mils, passing NFPA 101, Class A for smoke and flame spread, tested per ASTM E 84.

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. Exterior Doors (Energy Efficient): Face sheets fabricated of commercial quality hot-dipped zinc coated steel that complies with ASTM A924 A60. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level.

1. Design: Flush panel.

2. Core Construction: Foamed-in-place polyurethane and steel-reinforced core with no stiffener face welds.

   a. Provide 18 gauge steel vertical reinforcements 6 inches apart and welded in place. Foamed-in-place polyurethane core is chemically bonded to all interior surfaces. No face welding is permitted.
   b. Thermal properties to rate at a fully operable minimum U-Factor 0.374 and R-Value 2.53, including insulated door, Mercury thermal-break frame and threshold.
   c. Kerf Type Frames: Thermal properties to rate at a fully operable minimum U-Factor 0.378 and R-Value 2.5, including insulated door, kerf type frame, and threshold.

C. 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.

D. 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.

E. 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 083000

INTERIOR GLAZED PARTITION SYSTEMS

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 interior glazed partition system as shown on the drawings and/or specified herein, including but not limited to the following:

1. Partition system.

2. Doors and frames in partition system.

3. Finish hardware for doors.

1.3 RELATED SECTIONS

A. Hollow metal doors and frames - Section 081113.

B. Finish hardware - Section 087100.

C. Glass and glazing - Section 088000.

D. Drywall - Section 092900.

E. Electrical - Division 26.

1.4 QUALITY ASSURANCE

A. Manufacturer: Provide office partition system manufactured by a single firm specializing in production of this type of work.

B. Shop Assembly: Preassemble items in shop to greatest extent possible. Disassemble units only to extent necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

C. Installed partitions shall have a deflection limit of L/240 when subject to a 5 psf uniform lateral load and a concentrated load of 200 lbs.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's detailed materials and fabrication specifications and installation instructions. Include catalog cuts of hardware, fastenings and other data as required.

B. Shop Drawings: Submit shop drawings for fabrication and erection of partition assemblies which are not fully described by manufacturer's data. Show anchorage and accessory items and finishes.

C. Samples: Submit samples of each required finish and color. Prepare samples on same materials which will be used in partition assemblies.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver demountable panel partition components cartoned or crated to provide protection during transit and job storage.

B. Inspect partition components upon delivery for damage. Minor damages may be repaired, provided finish items are equal to new work and acceptable to Architect. Remove and replace damaged items as directed.

C. Store partition components on raised platforms in vertical positions with blocking between units to allow air circulation. Keep stored material covered and protected from damage.

PART 2 PRODUCTS

2.1 PARTITION SYSTEM

A. Provide partition systems as manufactured by Verde as listed below or approved equal.

2.2 MATERIALS (CFM)

A. Provide Origins System.

1. Aluminum, 1-1/4” x 3” profile in powder coated white finsh

2. Glass: Low iron, Laminated, unless otherwise indicated.

3. Doors: 1-3/4” Swing aluminum doors with acoustic seals.

4. Hardware: As selected by Architect.

2.3 MATERIALS (ADMIN)

A. Provide Nature System.

1. Slim White Oak Frames (match millwork in Section 064023), 1-5/8” x 3” engineered trim, with integral steel supports and perimeter sound gasketing.

2. Stained finish to match millwork.

3. Glass: Low iron, Laminated, unless otherwise indicated.

4. Doors: 2-1/4” Swing aluminum doors with acoustic seals.

5. Hardware: As selected by Architect.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where interior glazed partitions 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 by the Contractor in a manner acceptable to the Architect.

3.2 INSTALLATION

A. Install partitions before floor coverings and after suspended drywall ceilings have been installed. Coordinate partition work with work of other trades which are affected by partition installation. Avoid damage to installed work.

B. Repair damaged or defaced work or replace with new work, as acceptable to Architect. Completely refinish defaced partition components with factory finished materials, or replace defaced components.

C. Furnish, drill for and install anchoring devices required, and secure partitions to floor, ceiling and walls, using concealed fasteners.

D. Install partitions rigid, level, plumb and in alignment, with components secure together, in accordance with manufacturer's instructions.

E. Provide through posts to ceiling, or other concealed supports as required to assure lateral stability of partition runs.

F. Install continuous and positive seal to prevent light and sound transmission at partition contacts with floor, ceiling, wall and other abutting surfaces.

G. Adjust hardware and doors and leave in proper operating condition.

END OF SECTION

SECTION 083113

ACCESS 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 access panels 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 masonry and 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. Masonry shafts for pipes and conduits, as required.
g. Pipe spaces, if required.
h. Inlets of fans.
i. Fusible link and splitter damper at filter bank.
j. Automatic damper and motor.
k. Equipment not otherwise accessible.

1.3 RELATED SECTIONS

A. Unit Masonry - Section 042000.

B. Gypsum Drywall - Section 092900.

C. Ceramic Tiling - Section 093013.

D. 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 exposed masonry and tile finishes.

1. For installation in masonry construction, provide frames with adjustable metal masonry anchors.

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. 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.

G. Inserts and Anchorage: Furnish inserts and anchoring devices which must be built into masonry for the installation of access panels. Provide setting drawings, templates,

instructions, and directions for installation of anchorage devices. Coordinate delivery with other work to avoid delay.

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, fire-rated and unrated.

2. Hardware and accessories.

3. Motor operation.

4. Manual operation.

1.3 RELATED SECTIONS

A. Finish Hardware - Section 087100.

B. 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. Cycle Life:

1. Design doors of standard construction for normal use of up to 20 cycles per day maximum, and an overall maximum of 50,000 operating cycles for the life of the door.

C. Seismic Performance:

1. Provide manufacturer’s seismic calculations confirming ASCE7-104.

D. Insulated Door Slat Material Requirements:

1. Flame Spread Index of 0 and a Smoke Developed Index of 10 as tested per ASTM E84

2. Sound Transmission Class (STC) rating up to 30 for the curtain and up to 32 for the entire assembly, as tested per ASTM E90 and based on testing a complete, operable assembly

3. Minimum R-value of 8.0 (U-value of 0.125) as calculated using the ASHRAE Handbook of Fundamentals

E. Provide each type of overhead coiling door by one manufacturer for entire project.

F. Wind Loading: Design and reinforce exterior overhead coiling doors to withstand a thirty (30) lb. per square foot wind loading pressure, unless otherwise indicated.

G. Rated Overhead Coiling Door Assemblies

1. Furnish roll up 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.

H. Air and Water Infiltration: Per Division 8 requirements.

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.

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 Cornell Cookson as listed below or equal by McKeon, Overhead Door Corp., Atlas Overhead Doors, or approved equal meeting these specifications.

1. Exterior: Cornell ESD30 Thermiser Max

2. Interior: Cornell ESD10.

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 overhead coiling 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 roll up door opening head to support coil brackets, unless otherwise shown. Place anchor bolts on exterior wall guides so they are concealed when roll up 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.

G. Chain Operated, where indicated on drawings.

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 hoods of aluminum sheet of alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated; 0.040" minimum thickness, complying with ASTM B 209.

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 finish paint ferrous metal and galvanized surfaces, exposed and unexposed, except faying and lubricated surfaces, with door manufacturer's standard rust inhibitive primer.

B. Color: RAL 7024 Graphite Grey.

2.6 ELECTRIC DOOR OPERATORS (WHERE INDICATED)

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 083919

WATERTIGHT ACCESS HATCH

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this Section.

1.2 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the watertight access hatch as indicated on the drawings and/or specified herein.

1.3 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."

B. Comply with applicable provisions of the following specifications and documents:

1. Aluminum Association "Aluminum Design Manual."

2. AISC "Specification for Design Fabrication and Erection of Structural Steel for Buildings."

3. FEMA Bulletins 3-93 #102, #114.

C. Preinstallation Conference: Conduct conference at Project site to comply with requirements of Section 013119 "Project Meetings." Review methods and procedures related to flood protection panel 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.

1.4 SUBMITTALS

A. Product Data: For each type of flood protection panel indicated. Include construction details relative to materials, individual components and profiles, finishes, and accessories for flood protection panels.

B. Shop Drawings: Show fabrication and installation details of flood protection panels. Include plans, elevations, sections, details, and attachments to other Work.

C. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Test Data: Provide test data certifying that the closure furnished, or one of similar design, has been satisfactorily tested to verify that it will withstand the designed hydrostatic pressure with no visible leakage.

E. Maintenance Data: For flood protection system to include in the maintenance manuals specified in Division 01.

F. Foundation Calculations: Provide calculations and shop drawings signed and sealed by a professional engineer licensed in the State of New York demonstrating compliance with loads, including seismic factor, slip slide factors, uplift and turnover and meet Corp of Engineers Design Manual and ACSE-7-05 Minimum Design Loads for Small Buildings and other Structures, including wind load.

1.5 PRODUCT CONDITIONS

A. Field Measurements: Where metal fabrications are indicated to fit walls and other construction, verify dimensions by field measurements before fabrication; indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction to avoid delaying the Work.

PART 2 PRODUCTS

2.1 STORM DETENTION TANK HATCH

A. Provide pressure hatch Product CM-1 by Chase Associates or approved equal.

1. Material: Type 316 stainless steel.

2. Cover: ASME flanged and dished hinged cover with handles.

3. Toggles: 12

4. Gasket Material: EPDM.

5. Pressure rating: 25 psi.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Advise installers of other work about specific requirements relating to flood protection door installation, including sizes of openings to receive flood protection panel, as well as locations of supports, inserts, and anchoring devices.

3.3 INSTALLATION

A. Install closures in accordance with manufacturer’s instructions and approved shop drawings. Frames and embeds shall be installed level, square and rigid.

B. Bolted frames shall be sealed with an approved sealant.

3.4 MAINTENANCE MANUALS

A. Provide manual describing demounting removal and installation instructions for complete flood protection systems.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Arrange for flood protection system manufacturer's technical personnel to inspect installation on completion and submit repot to Architect.

1. All welds in the path of potential leaks shall be liquid penetrant inspected in accordance with Appendix VIII of Section VIII Div. 1 of ASME Code.

2. Notify Architect and OBO 48 hours in advance of date of inspection.

3.6 ADJUSTING AND CLEANING

A. Repair or replace flood protection panels that are warped, bowed, or otherwise damaged.

B. Clean installed products in accordance with manufacturer's instructions prior to OBO's acceptance.

END OF SECTION

SECTION 085100

METAL FRAMED WINDOWS AND 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 installation of the Exterior Metal Framed Windows as indicated on the drawings and/or specified herein, including, but not limited to, the following:

1. Exterior metal framed windows and doors at the CFM Building.

1.3 RELATED SECTIONS

A. Exterior Thermal Insulation – Section 072100

B. Exterior Self-Adhering Sheet Barriers – Section 072700

C. Exterior Insulated Metal Panel System – Section 074213

D. Sheet Metal Flashing – Section 076200

E. Joint Sealants – Section 079200

F. Exterior Glass and Glazing – Section 088000

1.4 REFERENCES

A. American National Standards Institute (ANSI):

1. ANSI Z97.1 Safety Glazing Materials Used in Buildings – Safety Performance Specifications and Methods of Test.

B. American Society for Testing and Materials (ASTM):

1. ASTM E774 – Standard Specification for Sealed Insulating Glass Units.

2. ASTM C920 Standard Specification for Elastomeric Joint Sealants

3. ASTM C1036 – Standard Specification for Flat Glass.

4. ASTM C1048 – Standard Specification for Heat-Treated Flat Glass—Kind HS, Kind FT Coated and Uncoated Glass.

5. ASTM E283-04, Test Method for Determining Rate of Airflow Through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen.

6. ASTM E330-02, Test Method for Structural Performance of Exterior Windows, Curtain Walls and Doors by Uniform Static Air Pressure Difference.

7. ASTM E331-00, Test Method for Water Penetration of Exterior Windows, Curtain Walls and Doors by Uniform Static Air Pressure Difference.

8. ASTM E774 – Standard Specification for Sealed Insulating Glass Units.

9. ASTM E2010-01: Standard Test Method for Positive Pressure Fire Tests of Window Assemblies.

C. Consumer Product Safety Commission (CPSC):

1. CPSC 16 CFR 1201 Categories I and II: Safety Standard for Glazing Materials.

D. Glass Association of North America (GANA):

1. GANA – Glazing Manual.

2. FGMA – Sealant Manual.

E. National Fire Protection Association (NFPA):

1. NFPA 80 – Fire Doors and Windows.

2. NFPA 257 – Fire Tests of Window Assemblies.

F. SIGMA TM-3000-90 – Vertical Glazing Guidelines.

G. Underwriters Laboratories, Inc. (UL):

1. UL 9 – Fire Tests of Window Assemblies.

2. UL 263 - Fire Tests of Building Construction and Materials

1.5 PERFORMANCE REQUIREMENTS

A. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440-08 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.

1. Window Certification: AAMA certified with label attached to each window.

B. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:

1. Minimum Performance Class for Windows: AW.

2. Minimum Performance Grade for Windows: PG80.

C. Air Infiltration:

1. Window: After the AAMA 910 life cycle test, meet AAMA 101 standard of maximum 0.10 cfm/sq.ft. when tested per ASTM E283 at a static air pressure differential of 6.24 psf (300PA).

2. Door: For single acting offset pivot or butt hung entrances in the closed and locked position, the test specimen shall be tested in accordance with ASTM E 283 at a pressure differential of 1.57 psf (75 Pa) for pairs of doors. A single 3'0" x 7'0" (915 mm x 2134 mm) entrance door and frame shall not exceed 1.0 cfm/ft^2.

D. Water Penetration:

1. Window: After the AAMA 910 life cycle test, no uncontrolled water leakage when tested per ASTM E 547 and ASTM E 331 at a static air pressure differential of 15 psf (720 PA).

E. Uniform Deflection:

1. Window: No more than L/175 when tested per ASTM E 330 at a static air pressure differential of 80 psf (3840 PA).

2. Door: No more than L/175 when tested per ASTM E 330 at a static air pressure differential of 50 psf (2400 PA).

F. Uniform Structural:

1. Window: Window to be operable, and maximum 0.2% permanent deformation per member when tested per ASTM E 330 at a static air pressure differential of 120 psf (5748 PA).

2. Door: At a structural test load equal to 1.5 times the specified design load, no glass breakage or permanent set in the framing members in excess of 0.2% of their clear spans shall occur.

G. Component Testing: Window components shall be tested in accordance with procedures described in ANSI AAMA/WDMA/CSA 101/I.S.2/A440 (NAFS).

H. Forced Entry Resistance:

1. Window: All windows shall conform to ASTM F588, Grad 10.

2. Door: Tested in accordance with AAMA 1304.

I. Energy Performance: Certify and label energy performance according to NFRC as follows:

1. Thermal Transmittance (U-factor): Assembly, center of glass, edge of glass, and frame areas shall have U-factors of not more than values as specified in the appendix for each wall type and as determined according to NFRC 100.

2. Solar Heat Gain Coefficient: Assembly, center of glass, and edge of glass areas shall have a solar heat gain coefficient no greater than values as specified in the appendix for each wall type and as determined according to NFRC 200.

3. Condensation Resistance: No surface condensation is allowed under the project boundary conditions.

J. Thermal Movements: Provide aluminum windows, including anchorage, 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, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: 120 deg F ambient and 180 deg F surface temperature changes.

K. Operable Units: Operable Units noted as ADA accessible shall be comply with requirements of AAMA/WDMA/CSA 101/I.S.2/A440-16 for operating force limits for applicable performance classes and window types.

L. Weep Holes: Provide as required in accordance with Manufacturer's system requirements.

1.6 SUBMITTALS

A. Action Submittals: Submit for review.

1. Product Data: For each type of product.

a. Include construction details, material descriptions, glazing and fabrication methods, dimensions of individual components and profiles, hardware, and finishes for aluminum windows.

2. Shop Drawings:

a. Include plans, elevations, sections, hardware, accessories, insect screens, operational clearances, and details of installation, including anchor, flashing, and sealant installation.

3. Thermal Performance and Condensation Calculations:

a. Submit calculations and/or test data demonstrating assembly U-Value and condensation resistance of glazing assembles. Condensation calculations shall include surrounding construction and shall accurately depict which surfaces have direct contact to interior conditioned air. Typical and atypical conditions shall be included.

b. Submit calculations and/or test data demonstrating solar shading and assembly U-Values across EWS assemblies.

4. Engineering Analysis Submittal

a. Engineering Analysis: All requirements specified herein shall be analytically and mathematically proven, except for those requirements called for to be proven exclusively by physical testing methods. Calculations and related data and their application in engineering, fabrication, assembly and installation shall be the responsibility of the Contractor's registered Professional Engineer.

b. Structural Design Calculations: Submit for review by the A/E structural design calculations for all components of the glazing assemblies. Indicate direction, location, and magnitude of all connected loads to the building structure coordinated to the building structure as shown in the Contract Documents.

c. Calculations shall demonstrate compliance with applicable sections of the International Building Code and the appropriate material reference specification for each component considered.

d. Calculations shall demonstrate that the system accommodates all relevant movements, including thermal movement and primary structure vertical and horizontal movements.

e. All calculation sheets shall be of one size and submission shall bear the seal of a Professional Engineer registered in the state of New York.

5. Glass / Glazing Analysis and Engineering Calculations:

a. Comply with Section 088000 Exterior Glazing.

6. Delegated-Design Submittal: For metal windows and doors, include analysis data signed and sealed by the qualified professional engineer licensed in the State of New York, responsible for their preparation.

7. Selection Samples:

a. For each exposed product and for each color specified, 2 by 4 inches in size.

b. Include Samples of hardware and accessories involving color selection.

8. Samples for Initial Selection: For units with factory-applied finishes.

a. Include Samples of hardware and accessories involving color selection.

9. Product Schedule:

a. For aluminum windows. Use same designations indicated on Drawings.

B. Informational Submittals:

1. Qualification Data: For manufacturer and Installer.

2. Product Test Reports: For each type of aluminum windows and doors, for tests performed by a qualified testing agency.

3. Testing Agencies: Qualified according to ASTM E 699 for testing indicated and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025.

4. Field quality-control reports.

5. Sample Warranties: For manufacturer's warranties.

6. Energy Performance Certification: For metal framed windows, doors, accessories, and components from manufacturer.

a. Basis for Certification: NFRC-certified energy performance values for each window and door type.

C. Closeout Submittals: Maintenance Data for windows and doors to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer capable of fabricating aluminum windows and doors that meet or exceed performance requirements indicated and of documenting this performance by test reports and calculations.

B. Installer Qualifications: An installer acceptable to aluminum window and door manufacturer for installation of units required for this Project.

C. Preinstallation Conference: Conduct conference at Project site.

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

2. Review and discuss the finishing of aluminum windows that is required to be coordinated with the finishing of other aluminum work for color and finish matching.

3. Review, discuss, and coordinate the interrelationship of aluminum windows with other exterior wall components. Include provisions for anchoring, flashing, weeping, sealing perimeters, and protecting finishes.

4. Review and discuss the sequence of work required to construct a watertight and weathertight exterior building envelope.

5. Inspect and discuss the condition of substrate and other preparatory work performed by other trades.

1.8 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace aluminum windows and doors that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to meet performance requirements.

b. Structural failures including excessive deflection, water leakage, condensation, and air infiltration.

c. Faulty operation of movable sash and hardware.

d. Deterioration of materials and finishes beyond normal weathering.

e. Failure of insulating glass.

2. Warranty Period:

a. Windows and Doors: 10 years from date of Substantial Completion.

b. Glazing Units: 10 years from date of Substantial Completion.

c. Aluminum Finish: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain aluminum windows and doors from single source from single manufacturer.

2.2 ALUMINUM WINDOWS AND DOORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Aluminum Windows

a. Basis-of-Design Product: Kawneer Series AA 4325 Ultra Thermal Windows or a comparable product by one of the following:

1) Oldcastle.

2) Schuco.

3) Wausau.

b. Types: Provide the following types in locations indicated on Drawings:

1) Casement.

2) Fixed.

2. Aluminum Doors

a. Basis-of-Design Product: Kawneer 250T Insulpour Thermal Entrance or a comparable product by one of the following:

1) Oldcastle.

2) Schuco.

3) Wausau.

B. Frames and Sashes: Aluminum extrusions complying with AAMA/WDMA/CSA 101/I.S.2/A440.

1. Thermally Broken Construction: Fabricate frames, sashes, and muntins with an integral, concealed, low-conductance thermal barrier located between exterior materials and window members exposed on interior side in a manner that eliminates direct metal-to-metal contact.

2. Thickness: Minimum wall thickness shall not be less than 0.125 inch.

C. Insulating-Glass Units: Comply with Section 088000 "Exterior Glass".

D. Weather Stripping: Provide full-perimeter weather stripping for each operable sash unless otherwise indicated.

E. Fasteners: Noncorrosive and compatible with window members, trim, hardware, anchors, and other components.

2.3 HARDWARE

A. General: Provide manufacturer's standard hardware complying with AAMA 907 or other corrosion-resistant material compatible with adjacent materials; designed to smoothly operate, tightly close, and securely lock windows, and sized to accommodate sash weight and dimensions.

1. Exposed Hardware Color and Finish: As selected by Architect from manufacturer's full range.

2. Casement Window Hardware:

a. Hinges: Non-friction type, not less than two per sash.

b. Lock: To be confirmed by Ownership.

c. Limit Devices: Concealed support arms with adjustable, limited, hold-open limit devices designed to restrict sash opening.

1) Limit clear opening to 4 inches or as required by the Relevant Building Code for ventilation; with custodial key release.

2.4 INSECT SCREENS

A. General: Fabricate insect screens to integrate with window frame. Provide screen for each operable exterior sash. Screen wickets are not permitted.

B. Glass-Fiber Mesh Fabric: 20-by-20 or 20-by-30 mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration. Comply with ASTM D3656/D3656M.

1. Mesh Color: Manufacturer's standard.

2.5 ACCESSORIES.

A. Glazing Tape: Closed cell polyvinyl chloride foam, coiled on release paper over adhesive on two sides, maximum water absorption by volume of 2 percent. Glass panels that exceed 1,393 sq. inches for 90-minute ratings must be glazed with fire-rated glazing tape supplied by manufacturer.

B. Glazing Compound: As recommended by Glazing Manufacturer.

C. Sealant: For sealants required within fabricated windows, provide manufacturer's standard, permanently elastic, non-shrinking, and non-migrating type recommended by sealant manufacturer for joint size and movement.

1. Provide cap bead/seal as required to meet performance requirements.

2. One-part neutral curing silicone, medium modulus sealant, Type S; Grade NS; Class 25 with additional movement capability of 50 percent in both extension and compression (total 100 percent); Uses (Exposure) NT*; Uses (Substrates) G, A, and O as applicable. Available Products:

a. Dow Corning 795 - Dow Corning Corp.

b. Silglaze-II 2800 - General Electric Co.

D. Setting Blocks: Neoprene, EPDM, or silicone; tested for compatibility with glazing compound; of 70 to 90 Shore A hardness.

E. Fasteners: Provide fasteners of bronze, brass, stainless steel, or other metal that are warranted by manufacturer to be noncorrosive and compatible with trim, hardware, anchors, and other components of fire-protection rated windows.

F. Anchors, Clips, and Window Accessories: Provide units of stainless steel, hot-dip zinc-coated steel, bronze, brass, or iron complying with ASTM A123/A123M. Provide units with sufficient strength to withstand design pressure indicated.

G. Cleaners, Primers, and Sealers: Type recommended by manufacturer of glass and gaskets.

H. Sub-sills: Thermally broken, extruded-aluminum sub-sills in configurations indicated on Drawings.

I. Interior Trim: Extruded-aluminum profiles in sizes and configurations indicated on Drawings.

J. Panning Trim: Extruded-aluminum profiles in sizes and configurations indicated on Drawings.

K. Receptor System: Two-piece, snap-together, thermally broken, extruded-aluminum receptor system that anchors windows in place.

2.6 FABRICATION

A. Fabricate windows in sizes indicated. Include a complete system for assembling components and anchoring windows.

B. Glaze windows in the factory.

C. Weather strip each operable sash to provide weathertight installation.

D. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.

E. Provide water-shed members above side-hinged sashes and similar lines of natural water penetration.

F. Window Assemblies: Provide operating and fixed units in configuration indicated. Provide window frames, sashes, hardware, and other trim and components necessary for a complete, secure, and weathertight installation, including the following:

1. Exterior head and sill casings and trim.

G. Complete fabrication, assembly, finishing, hardware application, and other work in the factory.

2.7 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual" 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. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.8 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

B. High-Performance Organic Finish (Two-Coat Fluoropolymer): AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coating; Organic Coating: 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). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2605 and with coating and resin manufacturers' written instructions.

1. Color and Gloss: As selected by Architect from full range of industry colors and color densities.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Verify rough opening dimensions, levelness of sill plate, and operational clearances.

C. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure weathertight window installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E2112.

B. SWI Publication: Comply with applicable requirements in SWI's "General Guidelines on the Installation of Steel Windows," except where more stringent requirements are indicated.

C. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction to produce weathertight construction.

D. Set sill members in bed of sealant or with gaskets, as indicated, to provide weathertight construction.

E. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.

F. Separate metal frames and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

G. Install glazing unit so that UL and Manufacturer’s markings remain permanently visible.

H. Window frames and glass shall be protected before, during and after installation until substantial completion.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.

B. Testing: Testing of windows for air infiltration and water resistance shall be performed according to AAMA 502. Each test includes the following:

1. Air-Infiltration Testing:

a. Test Pressure: That required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance class indicated.

b. Allowable Air-Leakage Rate: 1.0 times the applicable AAMA/WDMA/CSA 101/I.S.2/A440 rate for product type and performance class rounded down to one decimal place.

2. Water-Resistance Testing:

a. Test Pressure: Full test pressure required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance grade indicated.

b. Allowable Water Infiltration: No water penetration.

C. Testing Extent: Windows shall be tested after perimeter sealants have cured.

1. Fixed Windows: Perform tests in each test area, as directed by Architect. Test at least six locations in total, at 10, 30, and 70 percent completion as follows:

a. At 10% completion test 2 units

b. At 30% completion test 2 units

c. At 70% completion test 2 units

2. Operable Windows: Perform tests in each test area, as directed by Architect. Test at least six locations in total, at 10, 30, and 70 percent completion as follows:

a. At 10% completion test 2 units

b. At 30% completion test 2 units

c. At 70% completion test 2 units

D. Test Reports: Prepared according to AAMA 502.

E. Windows will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.4 RETESTING:

A. The amount and extent of retesting and remediation work required due to any failed test results shall be to the acceptance of the Architect and the Owner. All costs including testing agencies repair and remediation and retesting shall be at the Contractor's expense. Additional expense shall including consultants and owner's travel feels shall be at the Contractor's expense.

B. Tests resulting in water penetration shall require testing of an additional two (2) areas of similar configuration as selected by the Architect, in addition to retesting of the remediated initial test area.

3.5 ADJUSTING, CLEANING, AND PROTECTION

A. Adjust operating sashes and hardware for a tight fit at contact points and weather stripping for smooth operation and weathertight closure.

B. Clean exposed surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.

1. Keep protective films and coverings in place until final cleaning.

C. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

D. Protect window surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances do contact window surfaces, remove contaminants immediately according to manufacturer's written instructions.

1. Provide physical barrier protection to exterior window frame and glass from contact with construction material including masonry units, wet cement and mortar.

PART 4 - APPENDICE

4.1 WINDOW SCHEDULE

A. CFM Building

1. Fixed Metal Framed Windows

a. Window Type: Fixed

b. Glass Type: G-1, G-2 (See Architectural Drawings)

c. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 0.29 Btu/sq. ft. x h x deg F as determined according to NFRC 100.

d. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.34 as determined according to NFRC 200.

2. Operable Metal Framed Windows

a. Window Type: Outswing Casement

b. Glass Type: G-1

c. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 0.33 Btu/sq. ft. x h x deg F as determined according to NFRC 100.

d. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.26 as determined according to NFRC 200.

3. Metal Framed Doors

a. Door Type: Outswing Door

b. Glass Type: G-1

c. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 0.50 Btu/sq. ft. x h x deg F as determined according to NFRC 100.

d. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.25 as determined according to NFRC 200.

END OF SECTION 085100

SECTION 086200

UNIT SKYLIGHTS

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 unit skylights as shown on the drawings and/or specified herein.

1.3 SUBMITTALS

A. Product data for each type of skylight specified, including details of construction relative to materials, dimensions of individual components, profiles, finishes, and glazing light transmission and thermal characteristics.

B. Shop drawings showing fabrication and installation of skylights, including plans, elevations, sections, details of components, and attachments to other unit of Work

1.4 PERFORMANCE REQUIREMENTS

A. Test Performance Criteria: Provide unit skylights capable of complying with performance requirements indicated, based on testing manufacturer's unit skylights that are representative of those specified.

1. Structural Performance: Provide unit skylights, including glazing and anchorage, capable of withstanding the effects of the following design loads:

a. Downward Pressure: 170 psf.
b. Uplift Pressure: 70 psf.

2. Air Infiltration: Provide unit skylights with maximum air leakage through assembly of 0.2 cfm/sq. ft. when tested according to ASTM E 283 at a minimum static-air-pressure difference of 1.57 psf.

3. Water Penetration: Provide unit skylights that do not evidence water penetration through assembly when tested according to ASTM E 331 at a test pressure differential of 15.0 psf.

4. Thermal Performance

a. U-Factor: 0.69 Btu/hr/ft^2/deg F or better (dome) and 0.48 Btu/hr/ft^2/deg F or better (fixed).
b. SHGC: 0.30 or better.

1.5 WARRANTY

A. Skylight Warranty: Provide written warranty signed by manufacturer, agreeing to repair or replace work that exhibits defects in materials or workmanship and guaranteeing weathertight and leak-free performance. "Defects" is defined as uncontrolled leakage of water and abnormal aging or deterioration.

1. Warranty Period: 20 years from date of Substantial Completion for insulating glass; 10 years from date of Substantial Completion for factory glazed unit components.

B. Finish Warranty: Provide written warranty signed by manufacturer agreeing to repair or replace work with finish defects. "Defects" is defined as peeling, chipping, chalking, fading, abnormal aging or deterioration, and failure to perform as required.

1. Warranty Period for Fluoropolymer Finish: 5 years from date of Substantial Completion for color and film integrity.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include Velux America Inc. or approved equal acceptable to the Architect.

1. Curb-Mounted Skylights CM-1 by Velux:

a. Type: Single units, rectangular shape, as shown.
b. Glazing Material: Double-glazed, laminated inner lite, heat-strengthened exterior lite.
c. Dome Type: Double dome, sealed.
d. Curb: Insulated extruded aluminum frame.

B. Available Manufacturers Subject to compliance with requirements, provide Model FCM fixed Skylight, curb-mounted skylights by Velux America Inc. or approved equal acceptable to the Architect.

1. Double Glazed Unit:

a. 6mm Low Iron FT Glass
b. 12mm Cavity
c. 6mm Low iron FT Glass
d. Ultra Clear PVB
e. 6mm Low Iron Glass

2.2 MATERIALS

A. Exterior Aluminum Frame and Covers: Roll formed 0.06" thick aluminum frame coverings, prefinished, production engineered, and fabricated to fit exterior exposed surfaces.

B. Glazing: Structurally glazed, dual sealed insulating glass unit with 0.44" air space, stainless steel spacer with desiccant, argon gas, primary seal polyisobutylene, secondary seal silicone.

1. Provide Type 10 (Snowload Glazing) with exterior lite of 1/8" clear tempered glass with low-E coating on the #2 surface, argon gas air space, and interior lite consisting of two plies of 0.090" heat-strengthened laminated glass with 0.030" vinyl interlayer.

C. Fasteners: Same metal as metals being fastened, or nonmagnetic stainless steel or other non-corrosive metal as recommended by manufacturer. Match finish of exposed fasteners with finish of material being fastened.

D. Weather Stripping: Factory applied neoprene and thermoplastic elastomeric weather stripping throughout entire frame, profiled to effect weather seal.

E. Mastic Sealant: Polyisobutylene; non-hardening, non-skinning, non-drying, non-migrating sealant.

F. Elastomeric Sealant: Generic type recommended by unit manufacturer that is compatible with joint surfaces. ASTM C 920; Type S; Grade NS; Class 25; and Uses NT, G, A, and (as applicable to joint substrates indicated) O.

2.3 FINISH FOR ALUMINUM

A. Fluoropolymer, Two-Coat Coating System: Manufacturer's standard two-coat thermocured system, complying with AAMA 605.2, composed of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene resin by weight; complying with AAMA 605.2.

1. Color and Gloss: As selected by Architect from manufacturer's standard choices for color and gloss.

2.4 FABRICATION

A. General: Factory-assembled unit consisting of specified glazing, extruded aluminum glazing retainer, gasketing, inner frame designed to mount on separate curb, and self-contained flashing.

B. Curb: Provide curbs with cants or formed flashing flange to receive roof flashing and counterflashing. Material TPO.

C. Condensation Control: Fabricate skylight units with integral internal gutters and non-clogging weeps to collect and dispose of condensation.

D. Thermal Break: Fabricate skylight units with thermal barrier separating interior metal framing from materials exposed to outside temperature.

E. Glazing Gaskets: Manufacturer's standard glazing system of EPDM or neoprene, closed-cell sponge neoprene, or EPDM, or of partially vulcanized butyl tape or liquid-applied elastomeric sealant.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where unit skylights 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. General: Conform with manufacturer's instructions and recommendations. Coordinate with installation of roof deck and other substrates to receive skylight units. Coordinate with installation of vapor barriers, roof insulation, roofing, and flashing as required to assure 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.

1. Except as otherwise indicated, install roof skylights according to construction details of "NRCA Roofing and Waterproofing Manual".

B. Isolation: Where metal surfaces of units are to be installed in contact with incompatible metal or corrosive substrates, including wood, apply bituminous coating on concealed metal surfaces, or provide another permanent separation.

C. Flange Seals: Except as otherwise indicated, set flanges of accessory units in a thick bed of roofing cement to form a seal.

D. Cap Flashing: Where cap flashing is required as component of the skylight, install to provide an adequate waterproof overlap with roofing or roof flashing (as counterflashing). Seal with thick bead of mastic sealant, except where overlap is indicated to be left open for ventilation.

3.3 CLEANING AND PROTECTION

A. Clean exposed metal surfaces according to manufacturer's instructions. Touch up damaged metal coatings.

END OF SECTION

SECTION 087100

DOOR HARDWARE (C.F.M. BUILDING)

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. This Section includes commercial door hardware for the following:

1. Swinging doors.
2. Other doors to the extent indicated.

B. Door hardware includes, but is not necessarily limited to, the following:

1. Mechanical door hardware.
2. Electromechanical door hardware.
3. Cylinders specified for doors in other sections.

C. Related Sections:

1. Division 08 Section “Hollow Metal Doors and Frames”.
2. Division 08 Section “Aluminum-Framed Entrances and Storefronts”.

D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.

1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
2. ICC/IBC - International Building Code.
3. NFPA 70 - National Electrical Code.
4. NFPA 80 - Fire Doors and Windows.
5. NFPA 101 - Life Safety Code.
6. NFPA 105 - Installation of Smoke Door Assemblies.
7. State Building Codes, Local Amendments.

E. Standards: All hardware specified herein shall comply with the following industry standards as applicable. Any undated reference to a standard shall be interpreted as referring to the latest edition of that standard:

1. ANSI/BHMA Certified Product Standards - A156 Series.
2. UL10C - Positive Pressure Fire Tests of Door Assemblies.
3. ANSI/UL 294 - Access Control System Units.
4. UL 305 - Panic Hardware.

1.3 SUBMITTALS

A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.

B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."

2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.

3. Content: Include the following information:

a. Type, style, function, size, label, hand, and finish of each door hardware item.
b. Manufacturer of each item.
c. Fastenings and other pertinent information.
d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
e. Explanation of abbreviations, symbols, and codes contained in schedule.
f. Mounting locations for door hardware.
g. Door and frame sizes and materials.
h. Warranty information for each product.

4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.

C. Shop Drawings: Details of electrified access control hardware indicating the following:

1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:

a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
b. Complete (risers, point-to-point) access control system block wiring diagrams.
c. Wiring instructions for each electronic component scheduled herein.

2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.

D. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.

E. Informational Submittals:

1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.

F. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Procedures.

1.4 QUALITY ASSURANCE

A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.

B. Certified Products: Where specified, products must maintain a current listing in the Builders Hardware Manufacturers Association (BHMA) Certified Products Directory (CPD).

C. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

D. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.

E. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.

1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.

2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.

F. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.

G. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:

1. Function of building, purpose of each area and degree of security required.
2. Plans for existing and future key system expansion.
3. Requirements for key control storage and software.

4. Installation of permanent keys, cylinder cores and software.
5. Address and requirements for delivery of keys.

H. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.

1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
3. Review sequence of operation narratives for each unique access controlled opening.
4. Review and finalize construction schedule and verify availability of materials.
5. Review the required inspecting, testing, commissioning, and demonstration procedures

I. At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedule.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.

B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.

C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.6 COORDINATION

A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.

B. Door Hardware and Electrical Connections: Coordinate the layout and installation of scheduled electrified door hardware and related access control equipment with required connections to source power junction boxes, low voltage power supplies, detection and monitoring hardware, and fire and detection alarm systems.

C. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.7 WARRANTY

A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:

1. Structural failures including excessive deflection, cracking, or breakage.
2. Faulty operation of the hardware.
3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
4. Electrical component defects and failures within the systems operation.

C. Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.

D. Special Warranty Periods:

1. Ten years for mortise locks and latches.
2. Five years for exit hardware.
3. Twenty five years for manual overhead door closer bodies.
4. Two years for electromechanical door hardware.

1.8 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.

B. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:

1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.

C. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

2.2 HANGING DEVICES

A. Hinges: ANSI/BHMA A156.1 certified butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.

1. Quantity: Provide the following hinge quantity:

a. Two Hinges: For doors with heights up to 60 inches.
b. Three Hinges: For doors with heights 61 to 90 inches.
c. Four Hinges: For doors with heights 91 to 120 inches.
d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.

2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:

a. Widths up to 3’0”: 4-1/2” standard or heavy weight as specified.
b. Sizes from 3’1” to 4’0”: 5” heavy weight.

3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:

a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.

4. Hinge Options: Comply with the following:

a. Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.

5. Manufacturers:

a. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK).

B. Continuous Geared Hinges: ANSI/BHMA A156.26 Grade 1-600 certified continuous geared hinge. with minimum 0.120-inch thick extruded 6060 T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Factory trim hinges to suit door height and prepare for electrical cut-outs.

1. Manufacturers:

a. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).

C. Pivots: ANSI/BHMA A156.4, Grade 1, certified. Space intermediate pivots equally not less than 25 inches on center apart or not more than 35 inches on center for doors over 121 inches high. Pivot hinges to have oil impregnated bronze bearing in the top pivot and a radial roller and thrust bearing in the bottom pivot with the bottom pivot designed to carry the full weight of the door. Pivots to be UL listed for windstorm where applicable.

1. Manufacturers:

a. Rixson Door Controls (RF).

2.3 POWER TRANSFER DEVICES

A. Electrified Quick Connect Intermediate Transfer Pivots: Provide electrified offset intermediate transfer pivot hinges with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

1. Manufacturers:

a. Rixson Door Controls (RF) - E-M19-QC (# wires).

B. Concealed Quick Connect Electric Power Transfers: Provide concealed wiring pathway housing mortised into the door and frame for low voltage electrified door hardware. Furnish with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

1. Manufacturers:

a. Securitron (SU) - EL-CEPT Series.

C. Electric Door Wire Harnesses: Provide electric/data transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number and type of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.

1. Provide one each of the following tools as part of the base bid contract:

a. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - Electrical Connecting Kit: QC-R001.
b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - Connector Hand Tool: QC-R003.

2. Manufacturers:

a. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - QC-C Series.

2.4 DOOR OPERATING TRIM

A. Flush Bolts and Surface Bolts: ANSI/BHMA A156.3 and A156.16, Grade 1, certified.

1. Flush bolts to be furnished with top rod of sufficient length to allow bolt retraction device location approximately six feet from the floor.
2. Furnish dust proof strikes for bottom bolts.
3. Surface bolts to be minimum 8” in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable.
4. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.

5. Manufacturers:

    a. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).

B. Door Push Plates and Pulls: ANSI/BHMA A156.6 certified door pushes and pulls of type and design specified in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.

1. Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.
2. Door Pull and Push Bar Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door unless otherwise indicated.
3. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.
4. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.

5. Manufacturers:

    a. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).

2.5 CYLINDERS AND KEYING

A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.

B. Source Limitations: Obtain each type of keyed cylinder and keys from the same source manufacturer as locksets and exit devices, unless otherwise indicated.

1. Manufacturers:

    a. Corbin Russwin Hardware (RU).

C. Cylinder Types: Original manufacturer cylinders able to supply the following cylinder formats and types:

1. Threaded mortise cylinders with rings and cams to suit hardware application.
2. Rim cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
3. Bored or cylindrical lock cylinders with tailpieces as required to suit locks.
4. Tubular deadlocks and other auxiliary locks.
5. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
6. Keyway: Manufacturer’s Standard.

D. Removable Cores: Provide removable cores as specified, core insert, removable by use of a special key, and for use with only the core manufacturer's cylinder and door hardware.

E. Patented Cylinders: ANSI/BHMA A156.5, Grade 1 Certified Products Directory (CPD) listed cylinders employing a utility patented and restricted keyway requiring the use of a patented key. Cylinders are to be protected from unauthorized manufacture and distribution by manufacturer’s United States patents. Cylinders are to be factory keyed with owner having the ability for on-site original key cutting.

1. Patented key systems shall not be established with products that have an expired patent. Expired systems shall only be specified and supplied to support existing systems.

2. Manufacturers:

a. Corbin Russwin (RU) - Access 3 AP.

F. Keying System: Each type of lock and cylinders to be factory keyed.

1. Supplier shall conduct a "Keying Conference" to define and document keying system instructions and requirements.
2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
3. New System: Key locks to a new key system as directed by the Owner.

G. Key Quantity: Provide the following minimum number of keys:

1. Change Keys per Cylinder: Two (2)
2. Master Keys (per Master Key Level/Group): Five (5).
3. Construction Keys (where required): Ten (10).
4. Construction Control Keys (where required): Two (2).
5. Permanent Control Keys (where required): Two (2).

H. Construction Keying: Provide construction master keyed cylinders.

I. Construction Keying: Provide temporary keyed construction cores.

J. Key Registration List (Bitting List):

1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
2. Provide transcript list in writing or electronic file as directed by the Owner.

2.6 KEY CONTROL

A. Key Control Cabinet: Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet. Key control cabinet shall have expansion capacity of 150% of the number of locks required for the project.

1. Manufacturers:

a. Lund Equipment (LU).
b. MMF Industries (MM).
c. Telkee (TK).

2.7 MECHANICAL LOCKS AND LATCHING DEVICES

A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 Certified Products Directory (CPD) listed. Locksets are to be manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body.

1. Manufacturers:

a. Corbin Russwin Hardware (RU) - ML2000 Series.

2.8 ELECTROMECHANICAL LOCKING DEVICES

A. Electromechanical Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 Certified Products Directory (CPD) listed, subject to same compliance standards and requirements as mechanical mortise locksets, electrified locksets to be of type and design as specified below and in the hardware sets.

1. Electrified Lock Options: Where indicated in the Hardware Sets, provide electrified options including: outside door lock/unlock trim control, latchbolt and lock/unlock status monitoring, deadbolt monitoring, and request-to-exit signaling. Support end-of-line resistors contained within the lock case. Unless otherwise indicated, provide electrified locksets standard as fail secure.
2. Manufacturers:

a. Corbin Russwin Hardware (RU) - ML20900 Series.

2.9 LOCK AND LATCH STRIKES

A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.

B. Standards: Comply with the following:

1. Strikes for Mortise Locks and Latches: BHMA A156.13.
2. Strikes for Bored Locks and Latches: BHMA A156.2.
3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
4. Dustproof Strikes: BHMA A156.16.

2.10 CONVENTIONAL EXIT DEVICES

A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:

1. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.

2. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer’s catalog and template book for specific requirements.

3. Except on fire rated doors, provide exit devices with key cylinder dogging device to hold the pushbar and latch in a retracted position.

4. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.

5. Flush End Caps: Provide flush end caps made of architectural metal in the same finish as the devices as in the Hardware Sets. Plastic end caps will not be acceptable.

6. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.

   a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
   b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.

7. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.

8. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2” wide stiles.

9. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.

10. Extended cycle test: Devices to have been cycle tested to 9 million cycles.

11. Rail Sizing: Provide exit device rails factory sized for proper door width application.

12. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.

B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Exit device latch to be stainless steel, pullman type, with deadlock feature.

   1. Manufacturers:

      a. Corbin Russwin Hardware (RU) - ED4000 / ED5000 Series.

2.11 DOOR CLOSERS

A. All door closers specified herein shall meet or exceed the following criteria:

   1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers.

   2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.

   3. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the Americans with Disabilities Act, provide units complying with ANSI ICC/A117.1.

4. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.

5. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.

6. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.

B. Door Closers, Surface Mounted (Large Body Cast Iron): ANSI/BHMA A156.4, Grade 1 Certified Products Directory (CPD) listed surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control.

1. Manufacturers:

a. Corbin Russwin Hardware (RU) - DC8000 Series.
b. Norton Door Controls (NO) - 9500 Series.

2.12 ARCHITECTURAL TRIM

A. Door Protective Trim

1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.

2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1” LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.

3. Where plates are applied to fire rated doors with the top of the plate more than 16” above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer’s catalog and template book for specific requirements for size and applications.

4. Protection Plates: ANSI/BHMA A156.6 certified protection plates (kick, armor, or mop), fabricated from the following:

a. Stainless Steel: 300 grade, 050-inch thick.

5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.

6. Manufacturers:

a. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).

2.13 DOOR STOPS AND HOLDERS

A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.

B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 certified door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.

1. Manufacturers:

a. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).

C. Overhead Door Stops and Holders: ANSI/BHMA A156.8, Grade 1 Certified Products Directory (CPD) listed overhead stops and holders to be surface or concealed types as indicated in Hardware Sets. Track, slide, arm and jamb bracket to be constructed of extruded bronze and shock absorber spring of heavy tempered steel. Provide non-handed design with mounting brackets as required for proper operation and function.

1. Manufacturers:

a. Rixson Door Controls (RF).

2.14 ARCHITECTURAL SEALS

A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.

B. Coordinate thresholds with details and field conditions.

C. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.

1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.

D. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.

1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NPFA 252, Standard Methods of Fire Tests of Door Assemblies.

E. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.

F. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

G. Manufacturers:

1. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).

2.15 ELECTRONIC ACCESSORIES

A. Door Position Switches: Door position magnetic reed contact switches specifically designed for use in commercial door applications. On recessed models the contact and magnetic housing snap-lock into a 1" diameter hole. Surface mounted models include wide gap distance design complete with armored flex cabling. Provide SPDT, N/O switches with optional Rare Earth Magnet installation on steel doors with flush top channels.

1. Manufacturers:

a. Securitron (SU) - DPS Series.

B. Intelligent Switching Power Supplies: Provide power supplies with single, dual or multi-voltage configurations at 12 and/or 24VDC. Power Supply shall have battery backup function with an integrated battery charging circuit. The power supply shall have a standard, integrated Fire Alarm Interface (FAI). The power supply shall provide capability for secondary voltage, power distribution, direct lock control and network monitoring through add on modules. The power supply shall be expandable up to 16 individually protected outputs. Output modules shall provide individually protected, continuous outputs and/or individually protected, relay controlled outputs. Network modules shall provide remote monitoring functions such as status reporting, fault reporting and information logging.

1. Manufacturers:

a. Securitron (SU) - AQL Series.

2.16 FABRICATION

A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.17 FINISHES

A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.

B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware

C. 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 scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.

B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.

1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.

B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:

1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.

C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 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.

3.5 CLEANING AND PROTECTION

A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.

B. Clean adjacent surfaces soiled by door hardware installation.

C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.6 DEMONSTRATION

A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.7 DOOR HARDWARE SETS

A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should 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 and functionality.

1. Quantities listed are for each pair of doors, or for each single door.

2. The supplier is responsible for handing and sizing all products.

3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.

B. Manufacturer’s Abbreviations:

1. MK - McKinney
2. PE - Pemko
3. SU - Securitron
4. RF - Rixson
5. RO - Rockwood
6. RU - Corbin Russwin

Hardware Sets

Set: 1.0
Description: Alum - Meeting Room; Break Room

1 Continuous Hinge	CFM-HD1 Series	PE

1	Entrance Lock	ML2053 107X ACP	626	RU
1	Concealed Overhead Stop	1-X36	630	RF
1	Head & Jamb Seals	Supplied with door/frame assembly		00

Set: 2.0
Description: Exterior (Roof; Mechanical)

4	Hinge, Full Mortise, Hvy Wt	TA386	US32D	MK
1	Storeroom Lock	ML2057 107X ACP	626	RU
1	Surface Overhead Stop	9-X36	630	RF
1	Surface Closer (offset)	DC8210 A13	689	RU
1	Kick Plate	K1050 10" 4BE CSK	US32D	RO
1	Threshold (coord w/ details)	255x5AFG FHSL14SS-2		PE
1	Head & Jamb Gasketing	2891APK		PE
1	Sweep	315CN		PE
1	Position Switch (concealed)	DPS Series (coord w/ security)		SU

Set: 3.0
Description: Exterior - Applied Panel

1	Pivot Set	(F if rated) 147	626	RF
1	Intermediate Pivot	(F if rated) M190	626	RF
1	Storeroom Lock (2" panel max)	ML2057 107X PNL ACP	626	RU
1	Surface Overhead Stop	9-X36	630	RF
1	Surface Closer (offset)	DC8210 A13	689	RU
1	Kick Plate	K1050 10" 4BE CSK	US32D	RO
1	Threshold (coord w/ details)	255x5AFG FHSL14SS-2		PE
1	Head & Jamb Gasketing	2891APK		PE
1	Door Bottom (bottom edge)	3692APK773BL		PE
1	Position Switch (concealed)	DPS Series (coord w/ security)		SU

Set: 4.0
Description: Exterior - Applied Panel; Card / Keypad Access

1	Pivot Set	(F if rated) 147	626	RF
1	Electrified Inter Pivot	E(F)M19 QC-12	626	RF
1	Fail Secure Lock (2" panel max)	ML20906-SEC 107X PNL M92 ACP	626	RU
1	Surface Overhead Stop	9-X36	630	RF
1	Surface Closer (offset)	DC8210 A13	689	RU
1	Kick Plate	K1050 10" 4BE CSK	US32D	RO
1	Threshold (coord w/ details)	255x5AFG FHSL14SS-2		PE
1	Head & Jamb Gasketing	2891APK		PE
1	Door Bottom (bottom edge)	3692APK773BL		PE
1	Door Wiring Harness	QC Series (jamb to device)		MK
1	Frame Wiring Harness	QC Series (jamb to J-box)		MK
1	Position Switch (concealed)	DPS Series (coord w/ security)		SU
1	Power Supply	AQL4-R8-E1		SU
1	Card Reader / Keypad	By Security Vendor		00
1	Wiring Diagram (as required)	Elevation; Point-to-Point		

Notes:
Operation: Door is normally closed and locked. Valid credential at reader unlocks outside lever for momentary access. Monitoring by door position switch. During a loss of power the door will default to secure. Free egress at all times. Lock status will not change when the fire detection/suppression systems are activated. Rotating inside lever will activate request to exit switch for appropriate monitor by EAC systems. Outside key override.

Set: 5.0

Description: Stair

4	Hinge, Full Mortise, Hvy Wt	TA386	US32D	MK
1	Passage Latch	ML2010 107X	626	RU
1	Surface Closer	DC8200 A10; DC8210 A3	689	RU
1	Kick Plate	K1050 10" 4BE CSK	US32D	RO
1	Door Stop	401; 404; 441CU (or per spec)	US26D	RO
1	Head & Jamb Seal (adhesive)	S442BL		PE

Set: 6.0
Description: Electrical Unequal Pair

8	Hinge, Full Mortise, Hvy Wt	TA386	US32D	MK
1	Dust Proof Strike	570	US26D	RO
2	Flush Bolt (manual)	555	US26D	RO
1	Exit Device (mortise, storeroom)	ED5600AL 1079M59ET ACP	630	RU
1	Surface Closer	DC8200 A10; DC8210 A3	689	RU
2	Kick Plate	K1050 10" 4BE CSK	US32D	RO
2	Door Stop	401; 404; 441CU (or per spec)	US26D	RO
1	Threshold (coord w/ details)	271A FHSL14SS		PE
1	Head & Jamb Seal (adhesive)	S442BL		PE
1	Astragal Seal (adhesive)	S442BL		PE
2	Sweep	18061CNB		PE
1	Astragal (flat bar)	357SP		PE

Set: 7.0
Description: Electrical

4	Hinge, Full Mortise, Hvy Wt	TA786	US26D	MK
1	Exit Device (mortise, storeroom)	ED5600AL 1079M59ET ACP	630	RU
1	Surface Closer	DC8200 A10; DC8210 A3	689	RU
1	Kick Plate	K1050 10" 4BE CSK	US32D	RO
1	Door Stop	401; 404; 441CU (or per spec)	US26D	RO
1	Threshold (coord w/ details)	271A FHSL14SS		PE
1	Head & Jamb Seal (adhesive)	S442BL		PE
1	Sweep	18061CNB		PE

Set: 8.0
Description: Mechanical

4	Hinge, Full Mortise, Hvy Wt	TA786	US26D	MK
1	Storeroom Lock	ML2057 107X ACP	626	RU
1	Surface Closer	DC8200 A10; DC8210 A3	689	RU
1	Kick Plate	K1050 10" 4BE CSK	US32D	RO
1	Door Stop	401; 404; 441CU (or per spec)	US26D	RO
1	Threshold (coord w/ details)	271A FHSL14SS		PE
1	Head & Jamb Seal (adhesive)	S442BL		PE
1	Sweep	18061CNB		PE

Set: 9.0
Description: Circulation - Card / Keypad Access

4	Hinge, Full Mortise, Hvy Wt	TA386	US32D	MK
1	Electric Power Transfer	EL-CEPT		SU
1	Fail Secure Lock	ML20906-SEC 107X M92 ACP	626	RU
1	Surface Closer	DC8200 A10; DC8210 A3	689	RU
1	Kick Plate	K1050 10" 4BE CSK	US32D	RO

1	Door Stop	401; 404; 441CU (or per spec)	US26D	RO
1	Threshold (coord w/ details)	271A FHSL14SS		PE
1	Head & Jamb Seal (adhesive)	S442BL		PE
1	Sweep	18061CNB		PE
1	Door Wiring Harness	QC Series (jamb to device)		MK
1	Frame Wiring Harness	QC Series (jamb to J-box)		MK
1	Position Switch (concealed)	DPS Series (coord w/ security)		SU
1	Power Supply	AQL4-R8-E1		SU
1	Card Reader / Keypad	By Security Vendor		00
1	Wiring Diagram (as required)	Elevation; Point-to-Point		

Notes:
Operation: Door is normally closed and locked. Valid credential at reader unlocks outside lever for momentary access. Monitoring by door position switch. During a loss of power the door will default to secure. Free egress at all times. Lock status will not change when the fire detection/suppression systems are activated. Rotating inside lever will activate request to exit switch for appropriate monitor by EAC systems. Outside key override.

Set: 10.0
Description: Circulation

4	Hinge, Full Mortise, Hvy Wt	TA386	US32D	MK
1	Entrance Lock	ML2053 107X ACP	626	RU
1	Surface Closer	DC8200 A10; DC8210 A3	689	RU
1	Kick Plate	K1050 10" 4BE CSK	US32D	RO
1	Door Stop	401; 404; 441CU (or per spec)	US26D	RO
1	Threshold (coord w/ details)	271A FHSL14SS		PE
1	Head & Jamb Seal (adhesive)	S442BL		PE
1	Sweep	18061CNB		PE

Set: 11.0
Description: Circulation; Wood Working - Magnetic Contact

4	Hinge, Full Mortise, Hvy Wt	TA386	US32D	MK
1	Classroom Lock	ML2055 107X ACP	626	RU
1	Surface Closer	DC8200 A10; DC8210 A3	689	RU
1	Kick Plate	K1050 10" 4BE CSK	US32D	RO
1	Door Stop	401; 404; 441CU (or per spec)	US26D	RO
1	Threshold (coord w/ details)	271A FHSL14SS		PE
1	Head & Jamb Seal (adhesive)	S442BL		PE
1	Sweep	18061CNB		PE
1	Position Switch (concealed)	DPS Series (coord w/ security)		SU

Set: 12.0
Description: Soil Lab; Laundry; Janitor

4	Hinge, Full Mortise	TA314	US32D	MK
1	Classroom Lock	ML2055 107X ACP	626	RU
1	Surface Closer	DC8200 A10; DC8210 A3	689	RU
1	Kick Plate	K1050 10" 4BE CSK	US32D	RO
1	Door Stop	401; 404; 441CU (or per spec)	US26D	RO
3	Silencer	608		RO

Set: 13.0
Description: Secure Storage Pair - Card / Keypad Access

8	Hinge, Full Mortise, Hvy Wt	TA386	US32D	MK
1	Electric Power Transfer	EL-CEPT		SU

1	Dust Proof Strike	570	US26D	RO
2	Flush Bolt (manual)	555	US26D	RO
1	Fail Secure Lock	ML20906-SEC 107X M92 ACP	626	RU
1	Surface Closer	DC8200 A10; DC8210 A3	689	RU
2	Kick Plate	K1050 10" 4BE CSK	US32D	RO
2	Door Stop	401; 404; 441CU (or per spec)	US26D	RO
1	Threshold (coord w/ details)	271A FHSL14SS		PE
1	Head & Jamb Seal (adhesive)	S442BL		PE
1	Astragal (flat bar)	357SP		PE
1	Door Wiring Harness	QC Series (jamb to device)		MK
1	Frame Wiring Harness	QC Series (jamb to J-box)		MK
2	Position Switch (concealed)	DPS Series (coord w/ security)		SU
1	Power Supply	AQL4-R8-E1		SU
1	Card Reader / Keypad	By Security Vendor		00
1	Wiring Diagram (as required)	Elevation; Point-to-Point		

Notes:
Operation: Door is normally closed and locked. Valid credential at reader unlocks outside lever for momentary access. Monitoring by door position switch. During a loss of power the door will default to secure. Free egress at all times. Lock status will not change when the fire detection/suppression systems are activated. Rotating inside lever will activate request to exit switch for appropriate monitor by EAC systems. Outside key override.

Set: 14.0
Description: Storage; Electrical Pair

8	Hinge, Full Mortise, Hvy Wt	TA386	US32D	MK
1	Dust Proof Strike	570	US26D	RO
2	Flush Bolt (manual)	555	US26D	RO
1	Storeroom Lock	ML2057 107X ACP	626	RU
1	Surface Closer	DC8200 A10; DC8210 A3	689	RU
2	Kick Plate	K1050 10" 4BE CSK	US32D	RO
2	Door Stop	401; 404; 441CU (or per spec)	US26D	RO
1	Astragal (flat bar)	357SP		PE
2	Silencer	608		RO

Set: 15.0
Description: Restroom; Shower

4	Hinge, Full Mortise	TA314	US32D	MK
1	Privacy Lock	ML2060 107X M19V	626	RU
1	Surface Closer	DC8200 A10; DC8210 A3	689	RU
1	Kick Plate	K1050 10" 4BE CSK	US32D	RO
1	Mop Plate	K1050 4" 4BE CSK	US32D	RO
1	Door Stop	401; 404; 441CU (or per spec)	US26D	RO
3	Silencer	608		RO
1	Coat Hook	RM811	US26D	RO

Set: 16.0
Description: Overhead Door

1	Cylinder as required	Keyed to building system	626	RU
1	Hardware	Supplied with door assembly		00
1	Door Contact	By Security Vendor		00
1	Threshold (coord w/ details)	2746x6_FG FHSL14SS		PE

END OF SECTION 087100

SECTION 088000

EXTERIOR 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 glazing as indicated on the drawings and/or specified herein, including, but not limited to, the following:

1. Glazing Units for Exterior Metal Framed Windows & Doors.

2. Glazing Units for Exterior Wood Framed Windows & Doors.

1.3 RELATED REQUIREMENTS

1. Exterior Metal Framed Windows – Section 085100

2. Exterior Wood Framed Windows and Doors – Section 085200

3. Unit Skylights – Section 086200

4. Metal Framed Skylights - 086300

1.4 REFERENCES

A. Definitions:

1. Glass Manufacturers: Firms that produce primary glass, low-E coated glass, or both, as defined in referenced glazing publications.

2. Glass Fabricators: Firms that assemble coat glazing units.

3. Glass Thicknesses: Indicated by thickness designations in millimeters in accordance with ASTM C1036. Imperial measurements are nominal and are provided for general reference only.

4. IBC: International Building Code.

5. Interspace (Air Space): Space between lites of an insulating-glass unit filled with dehydrated air or specified inert glass.

B. Reference Standards: Edition current at the time of DOB filing.

1. ANSI Z97.1 Performance Specifications and Methods of Test for Safety Glazing Materials Used in Buildings
2. ASTM C162 Standard Terminology of Glass and Glass Products
3. ASTM C1036 Standard Specification for Flat Glass
4. ASTM C1048 Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass
5. ASTM C1376 Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass
6. ASTM E546 Standard Test Method for Frost/Dew Point of Sealed Insulating Glass Units
7. ASTM E576 Standard Test Method for Frost/Dew Point of Sealed Insulating Glass Units in the Vertical Position
8. ASTM E1300 Standard Practice for Determining Load Resistance of Glass in Buildings
9. ASTM E2188 Standard Test Method for Insulating Glass Unit Performance.
10. ASTM E2189 – Standard Method for Testing Resistance to Fogging in Insulating Glass Units.
11. ASTM E2190 Standard Specification for Insulating Glass Unit Performance and Evaluation (replaces ASTM E773, E774 CBA, CAN / CGSB 12.8)
12. EN 14179-1 Glass in building - Heat-soaked thermally-toughened soda lime silicate safety glass
13. CPSC 16 CFR 1201 Safety Standard for Architectural Glazing Materials
14. Glazing Association of North America (GANA)
    a. GANA Glazing Manual.
    b. GANA Sealant Manual.
15. Insulating Glass Manufacturers Alliance (IGMA) – Glazing Guidelines.

1.5 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.6 GENERAL REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, licensed in the State of New York to design glazing units.

B. Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

C. Heat Strengthened Glass: Unless noted otherwise, all glass substrates shall be kind Heat-Strengthened.

D. Annealed Glass: Is not permitted unless specifically noted otherwise.

E. Fully Tempered Glass: Provide where specifically noted in the glass type schedule or is required by the building code to comply with safety glazing requirements.

1. Fully tempered glass shall be heat-soak tested. 2 hour minimum dwell time.

F. Colors: Surfaces of materials exposed to view shall be approved by the Architect for color including insulating glass sealants and sealants.

1.7 PERFORMANCE REQUIREMENTS

A. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined in accordance with the IBC and ASTM E1300:

1. Design Wind Pressures:

a. Determine design wind pressures applicable to Project in accordance with ASCE/SEI 7, based on wind design data indicated on Structural Drawings and heights above grade indicated on Architectural Drawings.

2. Maximum Lateral Deflection:

a. For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch, whichever is less.

3. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.

4. Thickness: Where glass thickness is indicated, it is a minimum and provided for general coordination. Provide glass that complies with performance requirements and is not less than thickness indicated.

a. Minimum Glass Thickness for Exterior Lites: 6 mm.

B. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

C. Thermal and Optical Performance Properties: Provide glass with center-of-glass performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below. Refer to Related Sections for requirements for aggregate performance.

1. U-Factors: Center-of-glazing values, in accordance with NFRC 100 and based on LBL's WINDOW 7 computer program, expressed as Btu/sq. ft. x h x deg F.

2. Solar Heat Gain Coefficient: Center-of-glazing values, in accordance with NFRC 200 and based on LBL's WINDOW 7 computer program.

3. Visible Transmittance: Center-of-glazing values, in accordance with NFRC300.

1.8 SUBMITTALS

A. Action Submittals: Submit the following.

1. Product Data: For each type of product.

2. Glass Samples:

a. Selection Samples: 12 inch square.

b. Verification Samples 24 inch square. Include:

1) Actual glass thicknesses and makeup.

2) Spacer selected for insulating glass units.

c. Fabrication Samples: Not less than three full-size product units for each glass type.

1) Materials approved during verification process.

a) Show locations of spacer splice.

b) Frits.

3. Glazing Accessory Samples:

a. Selection Samples:

4. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

5. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by qualified professional engineer responsible for their preparation.

B. Informational Submittals

1. Qualification Data: For manufacturers of fabricated glass units.

2. Product Certificates:

a. For glass substrates.

b. Low-E Coatings.

3. Product Test Reports: For fabricated glass, for tests performed by a qualified testing agency.

4. Sample Warranties: For special warranties.

C. Closeout Submittals:

1. Cleaning instructions.

2. Product information, including low-E coating product.

1.9 QUALITY ASSURANCE

1. Fabricated-Glass Manufacturer Qualifications: A qualified manufacturer of fabricated glass units who is approved by primary glass manufacturer.

2. Installer Qualifications: A qualified glazing contractor for this Project who is certified under the North American Contractor Certification Program (NACC) for Architectural Glass & Metal (AG&M) contractors.

3. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.

4. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C1021 to conduct the testing indicated.

B. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."

C. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

D. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the IGCC.

E. Preinstallation Conference: Conduct conference at Project site.

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

2. Review temporary protection requirements for glazing during and after installation.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials in accordance with manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

B. Comply with insulating-glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.11 WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products:

1. Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period.

2. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.

3. Warranty Period: 10 years from date of Substantial Completion.

B. Manufacturer's Special Warranty for Insulating Glass:

1. Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period.

2. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions.

3. Evidence of failure is obstruction of vision by dust, moisture, or film on interior surfaces of glass.

4. Warranty Period: 10 years from date of Substantial Completion.

C. Manufacturer's Special Warranty for Heat-Soaked Tempered Glass:

1. Manufacturer agrees to replace heat-soaked tempered glass units that spontaneously break due to nickel sulfide (NiS) inclusions at a rate exceeding 0.3 percent (3/1000) within specified warranty period. Coverage for any other cause is excluded.

2. Warranty Period: 10 years from date of Substantial Completion.

1.12 EXTRA STOCK

A. TBD

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations, General:

1. Obtain each glass type from a single source.

2. Low-E coated glass: Obtain from single source and single manufacturer.

3. Glazing Accessories: For each product and installation method, obtain from single source from single manufacturer.

B. Source Limitations: Provide low-E coated glass products from one of the following Manufacturer.

1. AGC.

2. NSG/Pilkington Glass.

3. Saint Gobain Glass.

4. Guardian Industries.

5. Viracon.

6. Vitro (Formerly PPG).

C. Acceptable fabricators include but are not limited to:

1. J.E. Berkowitz.

2. Oldcastle.

3. Viracon.

2.2 GLASS PRODUCTS

A. Glass Substrates:

B. Standard Clear Float Glass: ASTM C1036, Type I, Class 1 (clear), Quality-Q3; and with visible light transmission of not less than 87 percent for reference glass thickness of 6 mm. Subject to compliance with requirements, provide products by one of the following:

1. AGC.

2. Guardian Glass.

3. Pilkington.

4. Saint Gobain Glass.

5. Vitro Architectural Glass.

C. Mid-iron Clear Float Glass: ASTM C1036, Type I, Class I (clear), Quality-Q3; and with visible light transmission of not less than 89 percent for reference glass thickness of 6 mm. Subject to compliance with requirements, available products that may be incorporated into the Work include but are not limited to the following:

1. Acuity; Vitro Architectural Glass.

2. ExtraClear; Guardian Glass.

3. Planiclear; Saint Gobain Glass.

D. Low-iron Ultra-Clear Glass: ASTM C1036, Type I, Class I (clear), Quality-Q3; and with visible light transmission of not less than 91 percent for reference glass thickness of 6 mm. Subject to compliance with requirements, available products that may be incorporated into the Work include but are not limited to the following:

1. Clearvision; AGC

2. Starphire; Vitro Architectural Glass.

3. Ultrawhite; Guardian Glass.

4. Optiwhite; Pilkington.

5. Diamant; Saint Gobain Glass.

E. Sputter-Coated Glass: ASTM C1376, glass with metallic-oxide or –nitride coating deposited by vacuum deposition process after manufacture and heat treatment (if any), and comply with other requirements that may be specified. Subject to compliance with requirements, provide products by one of the following manufacturers. Comply with specified Basis-of-Design product or an approved equal specified in the appendices of this section.

1. AGC Interpane.

2. Guardian Glass.

3. NorthGlass.

4. Saint Gobain Glass.

5. Viracon.

6. Vitro Architectural Glass.

2.3 ACCESORY PRODUCTS

A. Interlayers:

1. Polyvinyl Butyral (PVB) Interlayers:

a. Basis of Design Product: Trosifol XT UltraClear as manufactured by Kuraray.

b. Thickness: as needed to comply with requirements in the appendix.

c. Haze: Less than 2 percent haze Interlayer Tint: Optically Ultra-clear.

2. Interlayer: Ionomeric Polymer

   a. Basis of Design Product: SentryGlas as manufactured by Kuraray Americas Ltd.

   b. Thickness: as needed to comply with requirements in appendix.

   c. Haze: Less than 2 percent haze.

B. Spacer: Rigid plastic hybrid stainless steel (PHSS) insulating glass spacer.

1. Basis-of-Design Product, subject to compliance with requirements, provide:

   a. TGI-Spacer M from Technoform Glass Insulation North America, Inc.

   b. Chromatech from Rolltech A/S

2. Material:

   a. Co-extruded stainless steel and low conductivity polypropylenethermoplastic. Living Building Challenge Red List Free. PVC containing products are not acceptable. Compressible spacer materials such as foam are not acceptable. Aluminum box spacer are not acceptable.

   b. Stainless steel

3. Size: Specify size from manufacturer's standard sizes.

4. Color: Black, Gray, or Stainless steel. See the appendix.

5. UV stability: Must show color change of less than a delta E (Lab) of 3 under UV exposure per ASTM G154 cycle 1 (QUV) after 3000 hours of exposure for black and white spacer colors.

6. Effective conductivity, Keff : <;/=2.08 btu-in/hr.ft2 deg F for spacer sizes from 7/16 inch to 5/8 inch as shown by a test report from an independent test laboratory.

7. Provide C2C platinum level material health certificate.

C. Desiccant: Molecular sieve or silica gel or a blend of both.

1. Basis-of Design Product: Integral 3A desiccant.

D. Frit: Ceramic Enamel

1. Acceptable frit manufacturers include:
   a. Ferro

   b. Color: See appendix

E. Secondary Sealant for Insulating Glass Units: Silicone specifically intended for insulating glass units.

1. Basis of Design Product: Dow Corning 982 Silicone Insulating Glass Sealant.

2. Silicone Bite: As needed to comply with requirements in the appendix and façade performance requirements.

3. Color: To match Primary Sealant for Insulating Glass Units to within 5 Hunter Color Units

4. No voids in secondary seal or between primary and secondary seals.

5. Edge of spacer shall not be visible when viewed normal to surface of glazing assembly.

F. Primary Sealant for Insulating Glass Units: Polyisobutylene (PIB) specifically intended for insulating glass units.

1. Acceptable Manufacturers include: Adco Corp.

2. Minimum width of sealant application: As recommended by manufacturer but not less than 1/8 inch (3.175 mm).

3. Color: Black unless indicated otherwise in the appendix.

4. Edge of spacer shall not be visible when viewed normal to surface of glazing assembly.

2.4 FABRICATION

A. General:

1. Fabricate glazing units in sizes required to fit 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 publications, to comply with system performance requirements.

2. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.

a. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

B. Heat Treatment:

1. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

a. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

2. Heat-Strengthened Float Glass: ASTM C1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

a. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

C. Laminated Glass: ASTM C1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.

1. Construction: Laminate glass with an interlayer product to comply with interlayer manufacturer's written instructions.

2. Interlayer Thickness: Provide thickness as needed to comply with requirements but not less than 0.06 inch.

3. Interlayer Color: Optically clear unless otherwise indicated.

D. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified ASTM E2190 and with the IGCC certification for durability, volatile fog and argon retention performance.

1. Sealing System: Dual seal, with primary and secondary sealants.

2. Desiccant: Molecular sieve or silica gel, or a blend of both in all sides.

2.5 FINISHES

A. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.

B. Grind smooth and polish exposed glass edges and corners.

2.6 SOURCE QUALITY CONTROL

A. Flatness Tolerances (Roller-Wave or Ripple): The deviation from flatness at any peak shall be targeted not exceed 0.003 inch as measured per peak to valley for 1/4 inch (6mm) thick glass. (Electronic read out per lite is required as a submittal of this fabrication tolerance)

B. Bow and Warp: The bow and warp tolerances shall not exceed 1/32 inch per linear foot.

C. Tolerances For Heat-Treated Float Glass

1. Maximum Distortion Tolerances for Roll Wave and Millidiopter Measurement.

a. Glass to be heat treated in a plant utilizing convection furnaces and on-line diagnostic tools, Osprey Lite Measurement System or meeting the test criteria of the three contact gauge or flat bottom gauge described in ASTM C1651-1.

b. Roll-Wave or Ripple: The deviation from flatness at any peak to valley shall be targeted not exceed .003” as measured per peak to valley for 1/4” (6mm) thick glass. The leading and trailing 10’’edges of lite may exceed the targeted .003” and the deviation is allowable up to .008”.

c. Millidiopter: Surface quality of the lites to 90% surface coverage measured at a Maximum + or - 120 millidiopters overall.

d. Documentation of Quality Assurance Procedures will be performed on a regular statistical basis, in accordance with ISO 9001-2008 documents, and available upon request.

2. Bow and Warp Tolerance: Offline Measurement

a. Maximum of 1/2 of ASTM C1048 Specification.

b. Every Hour on Vertical Plane with aluminum straight edge / or tight string

c. Documentation of Quality Assurance Procedures shall be performed on a regular statistical basis, in accordance with the current editions of ISO 9001 documents, and to be made available upon request.

d. Glass to be heat-treated by horizontal (roller hearth) process with inherent roll-wave distortion parallel to the bottom edge of the glass unless otherwise specified.

e. Fully tempered glass shall be heat soaked to EN 14179-1:2005 European Heat Soak Standard.

2.7 EDGE FINISH OF GLASS

A. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.

B. Grind smooth and polish exposed glass edges and corners.

C. Exposed Edges: Flat edge (cut edge of glass is flat and surface edges are slightly arrissed with polished image.

D. Butt Edges: Flat edge (cut edge of glass is flat and surface edges are slightly arrissed with polished finish.

PART 3 - EXECUTION

3.1 GLAZING, GENERAL

A. Shop Glazing: Comply with written requirements of window manufacturers and door manufacturers.

3.2 CLEANING AND PROTECTION

A. Immediately after installation, remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. 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 buildup of dirt, scum, alkaline deposits, or stains.

1. If, despite such protection, contaminating substances do contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.

C. Remove and replace glass that is damaged during construction period.

D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

PART 4 - APPENDICES

4.1 GLASS SCHEDULE

A. Double Glazing Units for Framed Windows and Doors:

1. Locations or Systems of its use includes but are not limited to:

a. Double Glazed Metal Framed Windows at CFM Building.

b. Double Glazed Wood Framed Windows and Doors at the Pond Pavilion.

c. Double Glazed Wood Framed Doors at the Administration Building.

2. Glazing Type: G-1

3. Outboard Lite: 6mm Heat Strengthened Clear Glass with low-E coating on second surface. Fully temper if required for safety glazing requirements.

4. Interspace Content: 13.2mm warm edge spacer & Argon.

5. Inboard Lite: 6mm Heat Strengthened Clear Glass. Fully temper if required.

6. Basis-of-Design low-E product: VE-2M by Viracon or one of the following:

a. SunGuard Super Neutral 68 by Guardian Glass

b. Stopray Vision 72 by AGC Interpane

c. Solarban 60 by Vitro Architectural Glass

B. Double Glazing Units for Spandrel Framed Windows:

1. Locations or Systems of its use includes but are not limited to:

a. Double Glazed Metal Spandrel Framed Windows at CFM Building.

2. Glazing Type: G-2

3. Arrangement: Typically in groups of five panels. Refer to drawings.

4. Outboard Lite: 6mm Heat Strengthened Clear Glass with low-E coating on second surface. Fully temper if required for safety glazing requirements.

5. Interspace Content: 13.2mm warm edge spacer & Argon.

6. Inboard Lite: 6mm Heat Strengthened Clear Glass with solid ceramic frit on third surface. Fully temper if required.

7. Ceramic Coating: Coating to be selected by Architect.

8. Basis-of-Design low-E product: VE-2M by Viracon or one of the following:

a. SunGuard Super Neutral 68 by Guardian Glass

b. Stopray Vision 72 by AGC Interpane

c. Solarban 60 by Vitro Architectural Glass

C. Double Glazing Units for Framed Windows and Doors:

1. Locations or Systems of its use includes but are not limited to:

a. Double Glazed Wood Framed Windows and Doors at Ticketing

2. Glazing Type: G-3

3. Outboard Lite: 6mm Heat Strengthened Low-Iron Glass with low-E coating on second surface. Fully temper if required for safety glazing requirements.

4. Interspace Content: 13.2mm warm edge spacer & Argon.

5. Inboard Lite: 6mm Heat Strengthened Low-Iron Glass. Fully temper if required.

6. Basis-of-Design low-E product: VE-2M by Viracon or one of the following:

a. SunGuard Super Neutral 68 by Guardian Glass

b. Stopray Vision 72 by AGC Interpane

D. Triple Glazing Units for Framed Windows:

1. Locations or Systems of its use includes but are not limited to:

a. Triple Glazed Wood Framed Windows at the Administration Building.

2. Glazing Type: G-4

3. Outboard Lite: 6mm Heat Strengthened Clear Glass with low-E coating on second surface. Fully temper if required.

4. Interspace Content: 13.2mm warm edge spacer & Argon.

5. Mid-board Lite: 6mm Heat Strengthened Clear Glass. Fully temper if required for safety glazing requirements.

6. Interspace Content: 13.2mm warm edge spacer & Argon.

7. Inboard Lite: 6mm Heat Strengthened Clear Glass. Fully temper if required for safety glazing requirements.

8. Basis-of-Design Low-E product: VE-2M by Viracon or one of the following:

a. SunGuard Super Neutral 68 by Guardian Glass

b. Stopray Vision 72 by AGC Interpane

c. Solarban 60 by Vitro Architectural Glass

E. Double Glazing Units for Skylights:

1. Locations or Systems of its use includes but are not limited to:

a. Double Glazed Skylights at the Pond Pavilion.

2. Glazing Type: G-5

3. Outboard Lite: 6mm Fully Tempered Clear Glass with low-E coating on second surface.

4. Interspace Content: 13.2mm warm edge spacer & Argon.

5. Inboard Lite: Two plies of 6mm Fully Tempered Clear Glass, SGP laminated glass.

6. Basis-of-Design Low-E product: VE-2M by Viracon or one of the following:

a. SunGuard Super Neutral 68 by Guardian Glass

b. Stopray Vision 72 by AGC Interpane

c. Solarban 60 by Vitro Architectural Glass

F. Triple Glazing Units for Skylights:

1. Locations or Systems of its use includes but are not limited to:

a. Triple Glazed Skylight at the Administration Building.

2. Glazing Type: G-6

3. Outboard Lite: 6mm Fully Tempered Clear Glass with low-E coating on second surface.

4. Interspace Content: 13.2mm warm edge spacer & Argon.

5. Mid-board Lite: 6mm Fully Tempered Clear Glass.

6. Interspace Content: 13.2mm warm edge spacer & Argon.

7. Inboard Lite: Two plies of 6mm Fully Tempered Clear Glass, SGP laminated glass.

8. Basis-of-Design Low-E product: VE-2M by Viracon or one of the following:

a. SunGuard Super Neutral 68 by Guardian Glass

b. Stopray Vision 72 by AGC Interpane

c. Solarban 60 by Vitro Architectural Glass

END OF SECTION 088000

SECTION 088100

INTERIOR 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. Interior borrowed lites.

2. Interior frameless mirrors.

3. Back painted glass.

4. Frosted glass shower doors.

1.3 RELATED SECTIONS

A. Steel Doors and Frames - Section 081113.

B. 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. AAMA Publications: AAMA TIR-A7 Sloped Glazing Guidelines and Glass Design for Sloped Glazing.

3. LSGA Publications: LSGA Design Guide.

4. IGMA Publications: TM-3000 Vertical Glazing Guidelines and TB-3001 Sloped Glazing Guidelines.

5. 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.

6. 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.

7. Fire-Resistive Glazing Products for Window Assemblies: Products identical to those tested per ASTM E 163, labeled and listed by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.

8. ASTM C 920, Standard Specification for Elastomeric Joint Sealants.

9. 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 Code.

1. 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.

2. 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.

3. 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 and/or snow loads and safety glazing requirements as shown, specified or recommended by the glass fabricator and as required by the New York State 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. 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."

E. 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.

3. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to local authorities. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

F. Manufacturer shall be ISO 9001-2000 Certified.

1.8 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.

1.9 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.

1.10 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 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 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.

1. Low Iron Tempered Glass: Provide "Starphire" by Vitro Architectural Glass, 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. Frosted Glass: Level 9 Privacy, low-iron frosted glass as selected by the Architect, minimum thickness of 1/4".

F. Back Painted Glass: Provide opaque glass as scheduled on the drawings.

G. Frameless Mirrors: 1/4", Quality q2, clear float glass with silver, copper, and organic coating, edges uniformly ground and polished.

1. Provide mirrors made with "Starphire" low-iron, tempered glass by Vitro Architectural Glass, or approved equal, tempered in accordance ASTM C 1048, thicknesses as indicated.

2.2 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. Backer Rod: Closed cell non-gassing polyethylene rod with rod diameter 25% wider than joint width.

D. 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.

E. 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.

F. 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.

G. 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.

H. Edge Blocks: Provide neoprene or silicone as required for compatibility with glazing sealants. Provide blocks with Shore A hardness of 55±5.

I. Spacers: Elastomeric blocks or continuous extrusions with a Shore A durometer hardness required by glass manufacturer to maintain glass lites in place.

J. Miscellaneous Glazing Materials: Provide sealant backer rods, primers, cleaners, and sealers of type recommended by glass and sealant manufacturers.

K. 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.

2.3 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. Install glass in prepared glazing channels and other framing members.

C. Install setting blocks in rabbets as recommended by referenced glazing standards in GANA's "Glazing Manual" and IGMA's "Glazing Guidelines."

D. Provide bite on glass, minimum edge and face clearances and glazing material tolerances recommended by GANA's "Glazing Manual."

E. Set glass lites in each series with uniform pattern, draw, bow and similar characteristics.

F. Distribute the weight of glass unit along the edge rather than the corner.

G. 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.

H. Protect glass edge damage during handling and installation.

I. Prevent glass from contact with contaminating substances that result from construction operations, such as weld spatter, fireproofing or plaster.

J. 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 shall 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. Joint Sealers - Section 079200.

B. 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 New York State Building Code, 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 or equal made by Airolite, Greenheck, Ruskin, or approved equal meeting these specifications.

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 Three-Coat System: Manufacturer’s standard three-coat, thermocured system consisting of specially formulated inhibitive primer and intermediate fluoropolymer color coat, both containing not less than 70 percent polyvinylidene fluoride resin by weight; and clear top coat; complying with AAMA 2605.

2. Color: 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

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, where indicated.

3. Acoustical insulation for gypsum drywall work.

4. Sealant for gypsum drywall work.

5. Concealed metal reinforcing for attachment of railings, toilet partitions 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. Wood Frame Construction - Section 061000.

B. Thermal Insulation - Section 072100.

C. Hollow metal door frames - Section 081113.

D. Access Doors - Section 083113.

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.

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.

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.

2. Furring Channels: Hat shaped, formed from galvanized steel, 25 U.S. Std. gauge.

   a. Product: ClarkDietrich; Furring Channel, or a comparable product.

3. "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.

4. 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.

5. 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.

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.

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 Wallboard: 5/8" thick" Sheetrock" by USG, "Gold Bond" by National Gypsum, or "Regular Gypsum" by CertainTeed Corp., 48" wide, in maximum lengths available to minimize end-to-end butt joints.

B. Gypsum Ceiling Board: 5/8" thick, sag-resistant, long edges tapered.

C. 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.

D. 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.

E. 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.

F. 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.

G. Moisture/Mold-Resistant Gypsum Wallboard (at all exterior walls 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.

H. 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 Lafarge/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.

I. Abuse-Resistant Wallboard: 5/8" thick "Sheetrock Brand Mold Tough AR" by USG, "Dens Armor Plus Abuse Resistant Panels" by Georgia-Pacific, "EXP Interior Extreme AR" or "Gold Bond Brand Hi-Abuse XP" by National Gypsum, "Protecta AR100" or "Protecta HIR 300" by Lafarge/Continental, or "AirRenew Extreme Abuse" by CertainTeed Corp., 48" wide, in maximum lengths available to minimize end-to-end butt joints.

1. Board must achieve a Level 1 rating per ASTM C 1629.

J. Acoustically-Enhanced Gypsum Board: Provide 5/8" thick "QuietRock EZ-Snap" by PABCO Gypsum, 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.

K. NOTE: Where plywood is indicated in gypsum wallboard assemblies, as detailed on drawings, provide plywood conforming to the following:

1. Provide APA Structural 1 Rated Sheathing, Interior grade or better, with span rating to suit stud spacing; thickness as noted on drawings.

2. Plywood 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. After treatment, kiln dry to a moisture content of fifteen (15) percent.

2.4 ACCESSORIES

A. Acoustical Insulation: Paper-less, non-combustible, semi-rigid mineral fiber mat, 2" thick, in walls (unless otherwise indicated), 3 lb./cu. ft. maximum density; Thermafiber "Thermafiber SAFB," Rockwool "Rockwool AFB" or approved equal.

B. Fasteners for Wallboard

1. Metal Stud Construction: 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.

2. Wood Stud Construction: Steel drill screws conforming to ASTM C 1002.

C. Laminating Adhesive: "Sheetrock Brand Joint Compound."

D. Metal Trim

1. 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".

2. Edge Beads: "Sheetrock Brand Paper Faced Metal Bead and Trim."

E. Partition/Concrete Ceiling Trim: Trim-Tex Super Seal Tear Away or approved equal.

F. 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.

G. Control Joints: ClarkDietrich; #093 Control Joint or No. 0.093 by USG.

H. Acoustical Sealant: USG "Acoustical Sealant" or "Tremco Acoustical Caulking" of Tremco Mfg. Co., "MasterSeal NP520" by BASF or approved equal.

I. Neoprene Gaskets: Conform to ASTM D 1056.

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.

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.

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 screwdriver, 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.

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 floor tile.

2. Ceramic wall tile and base.

3. Stone saddles.

4. Setting beds, grout and sealant.

5. Waterproofing membrane.

1.3 RELATED SECTIONS

A. Cast-in-Place Concrete - Section 033000.

B. Unit Masonry - Section 042000.

C. Gypsum Drywall - Section 092900.

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.

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. Glass tile shall meet ANSI A137.2.

C. Flooring 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

A. Source Limitations for Tile: Obtain tile of each type and color or finish from single source or producer.

1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.

B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from single manufacturer and each aggregate from single source or producer.

1. Obtain setting and grouting materials, except for unmodified Portland cement and aggregate, from single manufacturer.

2. Obtain waterproof/crack isolation membrane, except for sheet products, from manufacturer of setting and grouting materials.

C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer:

1. Stone thresholds.

2. Waterproof membrane.

3. Metal edge strips.

2.2 MANUFACTURERS OF TILE

A. Floors: Daltile 2 x 2 Abrasive Ceramic Tile (Color: Mushroom or Keystone Uptown Taupe) or approved equal.

B. Walls: Daltile 2 x 2 Light-Polished Ceramic Tile (Color: Artic White) or approved equal.

2.3 TRIM AND SPECIAL SHAPES

A. 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.

2.4 STONE SADDLES

A. Provide sound stone of variety selected by the Architect, 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.

2.5 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 Modified Mortar Bed

1. Laticrete 3701 Fortified Mortar Bed.

2. MAPEI, Modified Mortar Bed.

3. Pro Spec, Floor Mud with B-710 SBR Acrylic Additive.

F. Latex-Portland Cement Bond Coat, complying with ANSI A118.4 and ISO 13007, C2ES2P1 with minimum compressive strength of 400 psi.

1. Laticrete, 254 Platinum.

2. MAPEI, Keraflex Super.

3. Pro Spec; Permalastic System consisting of Permalastic Dryset Mortar and Permalastic Admixture.

G. Wall and Base Tile

1. Over masonry and concrete, use a mortar bed leveling coat conforming to ANSI A108.1A followed by a Latex Portland Cement Bond Coat: Laticrete "TriLite," MAPEI "Keraflex Super," or equal by Pro Spec, conforming to ANSI A118.4, ISO 13007-C2ES2P1, and TCA Detail W-211.

2. Over cement board, use a Latex Portland cement mortar bond coat: Laticrete "TriLite," MAPEI, "Keraflex Super," or equal by Pro Spec, conforming to ANSI A118.4, ISO 13007-C2ES2P1, and TCA Detail W-244; coat back of board with waterproof membrane as specified below.

3. Over glass mat water resistant gypsum backer board, use a latex Portland cement mortar bond coat: Laticrete "TriLite," MAPEI "Keraflex Super," or equal by Pro Spec, conforming to ANSI A118.4, ISO 13007- C2ES1P1, and TCA Detail W-245.

H. 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: Laticrete "254 Platinum" or MAPEI "Keraflex Super," conforming to ANSI A118.4, ISO 13007-C2ES1P1, and TCA Detail F-112.

I. 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: Laticrete "254 Platinum" or MAPEI "Keraflex Super" conforming to ANSI A118.4, ISO 13007-C2ES2P1, and waterproofing membrane conforming to TCA Detail F-122/122A.

J. Waterproofing Membrane: Complying with ANSI A118.10 and ANSI A118.12; and having IAPMO certification as a shower pan liner; provide "Hydro Ban" made by Laticrete International, "Mapelastic AquaDefense" by MAPEI with factory blended "Bio-Block Antimicrobial," ProSpec "B6000," or approved equal.

1. Reinforce membrane with polyester fabric where recommended by manufacturer.

2. Showers: B-415; run waterproofing up full height of walls.

K. Water: Clean, fresh and suitable for drinking.

L. Grout: Complying with A118.7; and ISO 13007, CG2WAF; for grouting ceramic tile, provide a commercial Portland cement grout, Laticrete "PermaColor" or "PermaColor Select," "Ultracolor Plus FA" (additive not required) made by MAPEI, or comparable product by Laticrete, Custom Building Products or approved equal; color as selected by the Architect.

1. Provide darker grout at wall base 4” above the floor level. Above that grout shall be white.

M. 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.

N. Sealer: Seal all grout joints and all unglazed tile using "StoneTech Heavy Duty Sealer" by Laticrete, "Sealer’s Choice 15 Gold" by Aqua Mix Inc. or "Ultracare Penetrating Plus Stone, Tile, and Grout Sealer" by MAPEI.

O. 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.

P. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, equal to "StoneTech Stone & Tile Cleaner" by Laticrete, "Concentrated Stone & Tile Cleaner" Aqua-Mix, "Ultracare Concentrated Tile & Grout Cleaner" by MAPEI, or approved equal, specifically approved for materials and installations indicated by tile and grout manufacturers.

2.6 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.

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 1/4" 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: 1/16" wide in ceramic tile.

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, C2ES1P1.

2. Wall tile over masonry or concrete using dry set mortar with latex additive - ANSI A118.4 and ISO 13007, C2ES1P1.

3. Floor tile using full mud set mortar - ANSI A118.4, A228.15, and ISO 13007, C2ES1P1.

4. Floor tile using dry set mortar with latex additive - ANSI A118.4, A118.15, and ISO 13007, C2ES1P1.

5. Floor tile over waterproofing membrane - A118.15, and ISO 13007, C2ES1P1.

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 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.

3.7 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 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 (095113.A)

A. Provide mineral fiber panels with have factory-applied white finish Ultima Vector as manufactured by Armstrong World Industries, or comparable product of USG Interiors, Inc., Rockwool Rockfon, or approved equal. Panels shall meet ASTM E 1264, Class A, with maximum UL flame spread of 25 and smoke developed of 50 per ASTM E 84.

2.2 WOOD VENEER PERFORATED PANELS (095113.B)

A. SOUNDPLY RF M25 Acoustic Wall Panels for interior installation 1" (25mm) 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 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.

E. 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.

F. NRC Performance: Noise Reduction Coefficient for acoustical panels to be no less than 1.00 using Type F6 direct mount without additional acoustical insulation.

G. STC Performance: Sound Transmission Class to be no less than 37 using ASTM Test Method E336.

H. Panel Stability: Linear contraction or expansion to not exceed 0.4% maximum variation in width or height per ASTM D1037.

I. Finish for Veneer-Faced Panels

1. Veneer Species: White oak.

2. Cut: Quarter sawn.

3. Grade: Select.

4. Matching Veneer Leaves: Book matched.

5. Matching Between Panels: Center balanced.

6. Finish: Stained to match Architect's sample.

2.3 SUSPENSION SYSTEM

A. Provide exposed tee, 2-way grid steel suspension system with low sheen white baked enamel finish as manufactured by Armstrong World Industries, or comparable product of USG Interiors, Inc., Chicago Metallic Corp., or approved equal.

B. 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.

C. 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.

D. 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.

E. Suspension systems shall conform to ASTM C 635, intermediate duty.

F. 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.

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 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. Accessories.

1.3 RELATED SECTIONS

A. Gypsum Drywall - Section 092900.

B. 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: Submit six (6) inch long samples of base.

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 1/4" thick, continuous vulcanized SBR rubber, top set straight base with pre-formed internal and external corner pieces, color to match wall color. Base shall conform to ASTM F 1861, Type TV, Group 1, as manufactured by Johnsonite, Nora Rubber Flooring, Armstrong, or approved equal.

1. 09-65-13.A3 for a 3" height.

2. 09-65-13.A6 for a 6" height.

2.2 ACCESSORIES

A. Adhesives: Waterproof, stabilized type, as recommended by the manufacturer for the type of service indicated.

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 OF RESILIENT BASE

A. 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.

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 096543

LINOLEUM 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 linoleum flooring, as shown on the drawings and/or specified herein, including, but not limited to, the following:

1. Linoleum sheet flooring and cove base.

2. Adhesive.

3. Accessories.

1.3 RELATED SECTIONS

A. Cast-in-Place Concrete - Section 033000.

B. Gypsum Drywall - Section 092900.

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.

B. Surface Burning Characteristics: Class 1 when tested in accordance with ASTM E 648/NFPA 253, Standard Test Method for Critical Radiant Flux. Meets 450 or less when tested in accordance with ASTM E 662/ NFPA 258, Standard Test Method for Smoke Density.

1.5 SUBMITTALS

A. Manufacturer's Data: For information only, submit manufacturer's technical information and installation instructions for type of resilient sheet flooring required.

B. Samples: Submit samples of each color of resilient sheet 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.

C. Maintenance Instructions: Submit two (2) copies of manufacturer's written instructions for recommended maintenance practices for each type of resilient sheet flooring.

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 tile 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 tile 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 LINOLEUM SHEET FLOORING

A. Basis of Design: 0.080" thick homogeneous linoleum sheet flooring of primarily natural materials consisting of linseed oil, wood flour, rosin binders, limestone and dry pigments mixed and calendered onto natural jute backing, in seventy-nine (79) inch wide rolls. Flame spread seventy-five (75) or less. Provide "Marmoleum Walton" as manufactured by Forbo or equivalent product of Armstrong, Johnsonite, or approved equal. Meets or exceeds all technical requirements as set forth in ASTM F 2034, Standard Specification for Linoleum Sheet Floor Covering, Type III.

1. Color(s): UNI and Cirrus 3371 Cement.

2.2 ACCESSORIES

A. Adhesives: Waterproof, stabilized type, as recommended by the manufacturer for the type of service indicated.

B. Heat Welding Rod: Color matched welding rod.

C. 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.

D. Concrete Slab Primer: Non-staining type as recommended by the sheet flooring manufacturer.

E. Finish: Per manufacturer.

F. Floor Cleaner: Per manufacturer.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where linoleum sheet 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. Subfloors: Prior to start of laying the sheet flooring, broom clean or vacuum all surfaces to be covered.

1. Lightly grind concrete subfloors with a terrazzo grinder to remove any trowel marks or other surface irregularities which will telegraph to the sheet 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.

2. Use leveling compound as recommended by sheet flooring manufacturer for filling small cracks and depressions in subfloors and generally level the floor.

3. Subfloor shall be level to ±1/8" in 10'-0" distance and 1/4" total maximum variation from level shown.

4. 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 sheet flooring manufacturer, prior to application of the adhesive. Apply in compliance with manufacturer's directions.

3.3 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. Flooring shall be installed to a tolerance of 1/8" in 10'-0" run; 1/32" offset at any location.

C. 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.

D. Provide integral cove base where scheduled, including cove support strip and aluminum top edge strip. Construct coved base in accordance the manufacturer's instructions.

E. 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.

F. Lay sheet flooring to substrate without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, or other surface imperfections.

G. 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.

H. Weld seams in linoleum sheet flooring in compliance with the manufacturer's instructions to provide a "seamless" installation.

I. 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.

3.4 CLEANING AND PROTECTION

A. Remove any excess adhesive or other surface blemishes from sheet flooring, using neutral type cleaners as recommended by the sheet flooring manufacturer. Protect installed flooring from damage by use of heavy Kraft paper or other covering.

B. Finishing: After completion of the project and just prior to the final inspection of the work, thoroughly clean tile floors and accessories. Finish as recommended by manufacturer.

END OF SECTION

SECTION 097200

WALLCOVERING

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 wallcovering as shown on the drawings and/or specified herein.

1.3 RELATED SECTIONS

A. Gypsum Drywall - Section 092900.

B. Painting and Finishing - Section 099000.

1.4 QUALITY ASSURANCE

A. Qualifications of Installers: For actual cutting and installation of wallcovering, use only thoroughly trained and experienced installers completely familiar with the installation recommendations of the manufacturer of the wallcovering used and completely familiar with the requirements of this work.

B. Manufacturer's Recommendations: The installation recommendations of the manufacturer of the wallcovering used, when approved by the Architect, shall be the basis for acceptance or rejection of actual installation methods used in this work.

C. Test Panels: Install three (3) test panels of full usable width, including one corner, in areas designated by the Architect. Replace test panels which are not acceptable to the Architect until satisfactory installation is achieved.

1.5 SUBMITTALS

A. Samples: Before any wallcovering is delivered to the job site, submit to the Architect samples of the full range of colors and patterns of wallcovering available from the selected manufacturer in the quality and type specified. Samples shall be a min. 36" x 36" in size.

B. Manufacturer’s Recommendations: Accompanying the samples, submit to the Architect copies of the manufacturer's current installation recommendations for the material proposed to be furnished and installed under this Section.

C. A Certificate of Compliance shall be furnished indicating conformance to the specification requirements. This requirement may be waived if fabric and adhesive packages and containers delivered to the job carry labels indicating weight of materials and fire hazard classification.

1.6 MAINTENANCE INSTRUCTION

A. Furnish the Owner with a copy of the fabric manufacturer's maintenance instructions. These instructions shall contain recommended cleaning materials, application methods, and

precautions to be followed in the use of cleaning materials which may be detrimental to the surface if improperly applied.

1.7 EXTRA WALLCOVERING

A. Deliver to the Owner sizable remnants for future patching purposes. Also furnish to the Owner one (1) complete roll of each wallcovering used.

1.8 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver and store all wallcovering in undamaged condition as packaged by the manufacturer, with manufacturer's seal and labels intact. Exercise care to prevent damage during delivery, handling and storage. Store all materials flat in a clean, dry area with maintained temperature above 40 deg. F.

1.9 ENVIRONMENTAL CONDITIONS

A. Wallcovering should be installed only when normal temperature and humidity conditions approximate the same conditions that will exist when the building is occupied.

B. Areas to receive wallcovering shall be a constant temperature of 70 deg. F. measured at base elevation and shall be maintained for 72 hrs. before, during and 48 hrs. after the application.

C. Remove wallcovering from its packaging and allow to acclimatize to the area of installation 24 hrs.

PART 2 PRODUCTS

2.1 MATERIALS

A. See finish schedule.

2.2 ACCESSORIES

A. Adhesive: "Sure Grip Plus Mold and Mildew-Proof Commercial Wall Covering Adhesive" made by The Zinsser Co. Inc. or approved equal.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where wallcovering 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. Remove wallcovering material from its packaging and allow to acclimatize to the area of installation 24 hrs. before application.

B. Remove switch plates, wall plates, and surface-mounted fixtures, where wallcovering is to be applied.

C. Prime and seal substrates in accordance with wallcovering manufacturer's recommendations for the type of substrate materials to be covered.

D. Surfaces to receive wallcovering shall be free from grit, loose particles and surface irregularities and shall meet the minimum requirements established by the wallcovering manufacturer. Fill all cracks and holes in gypsum board with patching compound and sandpaper smooth.

E. Provide tarpaulins, drop cloths and other suitable covers to protect adjacent and underlying surfaces which are likely to be stained, spotted or otherwise marked by wallpaper paste and application operations.

3.3 INSTALLATION

A. Place wallcovering panels consecutively in the order they are cut from rolls, including filling of spaces above or below openings. Hang by reversing alternate strips, except on match patterns.

B. Apply adhesive to back of wallcovering following adhesive manufacturer's instructions, using roller or paste brush. Install seams vertically and plumb, and at least 6" away from any corner; horizontal seams will not be permitted. Place wallcovering continuously over internal and external corners, going 12" beyond outside corners and 6" at inside corners. Overlap seams and double cut to assure tight closure. Roll, brush or use a broad knife to remove air bubbles, wrinkles, blisters and other defects. Cut wallcovering evenly to the edges of the outlet box or support.

C. Trim selvages as required to assure color uniformity and pattern match at seams.

D. Remove excess adhesive along finished seams using warm water and a clean sponge, and wipe dry.

E. Install wallcovering with an intimate substrate bond, smooth, clean, without wrinkles, gaps and overlaps.

F. Replace removed plates and fixtures to verify cut edges of wallcovering are completely concealed.

G. Verify that pattern and color are as specified. If pattern is not random, examine for repeat in design.

H. Hang smooth, non-match patterns by pasting strips on the wall, overlapping the edges, and "Double-Cutting" through both thicknesses. Use a 0.04" or 0.06" zinc or aluminum strip between wall and strip when cutting, to avoid gouging the wall.

I. Use stiff-bristled brush or flexible board knife to eliminate air pockets and to secure the wallcovering to the wall surface.

J. Fill spaces above and below doors and similar areas in sequence from the roll, not later than when all full-length pieces have been installed.

K. Examine each seam carefully when completed. Trim additional selvage where required to achieve a color and pattern match at seams.

L. Apply wallcovering before the installation of plumbing fixtures, casings, bases and cabinets.

3.4 PROTECTION

A. Protect finished work installed by other trades prior to work under this Section. Replace any work damaged by workmen of this trade without cost to the Owner.

3.5 CLEAN-UP

A. Any hardware, accessories, plates, etc., which are removed during wallcovering installation shall be replaced level and square.

B. All debris resulting from work covered in this Section shall be removed from the building on a daily basis.

END OF SECTION

SECTION 097800

REINFORCED PLASTIC PANELING SYSTEM

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 reinforced plastic paneling system as shown on the drawings and/or specified herein, including, but not limited to, the following:

1. Reinforced plastic paneling system.

2. Moldings.

1.3 RELATED SECTIONS

A. Gypsum drywall - Section 092900.

1.4 QUALITY ASSURANCE

A. Installer: A firm which has at least three years' experience in work of the type required by this section and which is acceptable to the manufacturers of the primary materials.

B. Source: Provide plastic panels which are the products of one manufacturer. Provide secondary materials, moldings and accessories which are acceptable to the panel manufacturer.

C. In-Place Samples: Before beginning primary work of this section, provide typical in-place samples of each item and type of work at locations acceptable to the Architect and obtain the Architect's acceptance of visual qualities.

1. Size of Sample: Not less than 32 square feet.

2. Intent of Sample: The intent of the in-place sample is to obtain approval of a typical installation as early as possible so that problems, if any, can be corrected before the problem is repeated.

3. Sample Disposition: Acceptable in-place samples may be incorporated into the finished work. Protect and maintain acceptable in-place samples throughout the work of this section to serve as criteria for acceptance of the work

D. Burning Characteristics: Provide materials whose surface burning characteristics, when tested in compliance with ASTM E 84 are classified as Class A or Class 1.

1.5 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. Initial Selection Samples: Submit minimum 3" x 3" samples showing complete range of colors, textures, and finishes available for each material used.

1.6 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. Protect from all possible damage. Sequence deliveries to avoid delays, but minimize on-site storage.

PART 2 PRODUCTS

2.1 FIBERGLASS PLASTIC PANEL SYSTEM

A. Products: Provide one of the following products:

1. "Fiber-Lite Liner Panels," Nudo Products, Inc.

2. "Fire-X Glasbord," Crane Composites, Inc.

3. "Induro FRP," Marlite.

4. "Glasliner FRP Wall Panels," Glasteel Fiberglass Reinforced Panels, Division of Stabilit America, Inc.

B. Panel Characteristics: Provide one of the specified products having the following characteristics:

1. Thickness: Not less than 0.09" thick.

2. Texture: Manufacturer's standard pebble texture.

3. Panel Size: Provide largest sizes available to minimize joints and seams.

4. Colors: Provide panels and matching moldings and rivets as selected by the Architect from the manufacturer's standard colors.

C. Moldings: Provide vinyl moldings as recommended and approved by the panel manufacturer.

D. Panel Fasteners: Provide nylon rivets recommended by manufacturer for installing reinforced plastic panels to gypsum drywall and metal stud substrates. Do not use any metal in rivets.

E. Accessories: Provide all necessary sealants, components and accessories as recommended by panel manufacturer for a complete, sanitary, easy-to-clean installation. Use only sanitary, mold inhibiting USDA approved silicone sealant.

PART 3 EXECUTION

3.1 INSTALLATION

A. Pre-Installation Examination Required: The Installer shall examine previous work, related work, and conditions under which this work is to be performed and notify Contractor in writing of all deficiencies and conditions detrimental to the proper completion of this work. Beginning work means Installer accepts substrates, previous work, and conditions.

B. Manufacturer's Instructions: Strictly comply with manufacturer's instructions and recommendations, except where more restrictive requirements are specified in this section.

C. Installation: Mechanically attach panels to substrates indicated using non-metallic rivets at spacing recommended by panel manufacturer. Provide expansion clearance at all panel edges as required by manufacturer, but make sure moldings cover panel edges. Gaps are not permitted.

1. Trim and Molding: Provide moldings at all edges, joints, seams and corners. Provide moldings having the easiest to clean shapes and profiles available.

2. Sealing: Seal all edges, joints, seams, and corners as the work progresses.

D. Tolerances: The following allowable installed tolerances are allowable variations from locations and dimensions indicated by the Contract Documents and shall not be added to allowable tolerances indicated for other work.

1. Allowable Variation from True Plumb, Level, and Line: ± 1/8" in 20'-0".

2. Allowable Variation from True Plane: 1/8" in 10'-0".

3.2 CLEANING AND PROTECTION

A. Cleaning: Clean exposed surfaces using non-abrasive materials and methods recommended by manufacturer of material or product being cleaned. Remove and replace work that cannot be successfully cleaned or repaired.

B. Protection: Provide temporary protection to ensure work is without damage or deterioration at time of final acceptance. Remove protections and re-clean as necessary immediately before final acceptance.

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 interior concrete block exposed to view.

6. Painting gypsum drywall exposed to view.

7. Sealing concrete floors.

8. Exterior exposed wood structure.

9. 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.

10. Painting pipes, pipe coverings, conduit, ducts, insulation, hangers, supports and other mechanical and electrical items and equipment exposed to view.

11. Painting surfaces above, behind or below grilles, gratings, diffusers, louvers, lighting fixtures, and the like, which are exposed to view through these items.

12. Incidental painting and touching up as required to produce proper finish for painted surfaces, including touching up of factory finished items.

13. 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. Wallcovering - Section 097200.

D. 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 toilet partitions.

C. Factory-finished acoustical tile.

D. Non-ferrous metals, except for items specified and/or indicated to be painted.

E. Finished hardware, except for hardware that is factory primed.

F. 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 one of the manufacturers listed in the paint schedule (Section 2.4). These companies are Benjamin Moore, PPG Paint (Glidden Professional), and Sherwin Williams (S-W). 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 SCHEDULE OF FINISHES

A. High Performance Coating on Exterior Galvanized Ferrous Metals

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

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:	"Pittthane 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. Exterior wood water based sealer: Three Clear coats by Sansin Corporation designed for UV stability.

D. Interior Ferrous Metal

Satin Finish/Latex

Primer:	Benj. Moore Ultra Spec HP Acrylic Metal Primer (HP04) PPG Pitt Tech Plus DTM Acrylic Primer 4020 Sherwin-Williams Pro-Industrial Pro-Cryl Universal Primer B66-3100 Series
First Coat:	Benj. Moore Ultra Spec-HP DTM Acrylic Low Luster (HP25)

PPG Pitt Glaze WB1 Pre-Catalyzed Eggshell Epoxy 16-310
S-W Pro Industrial Acrylic Eg-Shel, B66-660 Series

Second Coat: Benj. Moore Ultra Spec-HP DTM Acrylic Low Luster (HP25)
PPG Pitt Glaze WB1 Pre-Catalyzed Eggshell Epoxy 16-310
S-W Pro Industrial Acrylic Eg-Shel, B66-660 Series

a. Total DFT not less than: 3.9 mils

Semi-Gloss Finish/Latex

Primer: Benj. Moore Ultra Spec-HP Acrylic Metal Primer (HP04)
PPG Devflex 4020 PF DTM Primer/Flat Finish
Sherwin-Williams Pro-Industrial Pro-Cryl Universal Primer B66-3100 Series

First Coat: Benj. Moore Ultra Spec HP DTM Acrylic Semi-Gloss (HP29)
PPG Pitt Glaze WB1 Pre-Catalyzed Semi-Gloss Epoxy 16-510
S-W Pro Industrial Acrylic Semi-Gloss, B66-650 Series

Second Coat: Benj. Moore Ultra Spec HP DTM Acrylic Semi-Gloss (HP29)
PPG Pitt Glaze WB1 Pre-Catalyzed Semi-Gloss Epoxy 16-510
S-W Pro Industrial Acrylic Semi-Gloss, B66-650 Series

a. Total DFT not less than: 4.0 mils

E. Interior Concrete Block

Flat Finish/Vinyl Acrylic Latex over Filler

Block Filler: Benj. Moore Ultra Spec Masonry Int./Ext. High Build Block Filler (571)
PPG Speedhide HI Fill Latex Block Filler 6-15XI
S-W Pro Industrial Heavy-Duty Block Filler, B42-150

First Coat: Benj. Moore Ultra Spec 500 Interior Flat Latex (N536)
PPG Speedhide Zero Interior Latex Flat 6-4110XI
S-W ProMar 200 Zero VOC Interior Latex Flat, B30-12600 Series

Second Coat: Benj. Moore Ultra Spec 500 Interior Flat Latex (N536)
PPG Speedhide Zero Interior Latex Flat 6-4110XI
S-W ProMar 200 Zero VOC Interior Latex Flat, B30-12600 Series

a. Total DFT not less than: 10.7 mils

Eggshell Finish/Vinyl Acrylic Latex Over Filler

Block Filler: Benj. Moore Ultra Spec Masonry Int./Ext. High Build Block Filler (571)
PPG Speedhide HI Fill Latex Block Filler 6-15XI
S-W Pro Industrial Heavy-Duty Block Filler, B42-150

First Coat: Benj. Moore Ultra Spec 500 Interior Latex Eggshell (N538)
PPG Speedhide Zero Interior Latex Eggshell 6-4310XI
S-W ProMar 200 Zero VOC Interior Latex Eggshell, B20-1900 Series

Second Coat: Benj. Moore Ultra Spec 500 Interior Latex Eggshell (N538)
PPG Speedhide Zero Interior Latex Eggshell 6-4310XI
S-W ProMar 200 Zero VOC Interior Latex Eggshell, B20-1900 Series

a. Total DFT not less than: 10.9 mils

Semi-Gloss Finish/Vinyl Acrylic Latex over Filler

Block Filler: Benj. Moore Ultra Spec Masonry Int./Ext. High Build Block Filler (571)
PPG Speedhide HI Fill Latex Block Filler 6-15XI
S-W Pro Industrial Heavy-Duty Block Filler, B42-150

First Coat: Benj. Moore Ultra Spec 500 Interior Latex Gloss (N540)
PPG Speedhide Zero Interior Semi-Gloss Latex, 6-4510XI Series
S-W ProMar 200 Zero VOC Interior Latex S. Gloss, B31-2600 Series

Second Coat: Benj. Moore Ultra Spec 500 Interior Latex Gloss (N540)
PPG Speedhide Zero Interior Semi-Gloss Latex, 6-4510XI Series
S-W ProMar 200 Zero VOC Interior Latex S. Gloss, B31-2600 Series

a. Total DFT not less than: 10.7 mils

F. Interior Drywall

Flat Finish/Vinyl Acrylic Latex
Primer: Benj. Moore Ultra Spec 500 Interior Latex Primer (N534)
PPG Speedhide Zero Interior Latex Primer 6-4900XI
S-W ProMar 200 Zero VOC Interior Latex Primer, B28-2600
First Coat: Benj. Moore Ultra Spec 500 Latex Flat (N536)
PPG Speedhide Zero Interior Latex Flat 6-4110XI
S-W ProMar 200 Zero VOC Interior Latex Flat, B30-2600 Series
Second Coat: Benj. Moore Ultra Spec 500 Latex Flat (N536)
PPG Speedhide Zero Interior Latex Flat 6-4110XI
S-W ProMar 200 Zero VOC Interior Latex Flat, B30-2600 Series
a. Total DFT not less than: 3.6 mils

Eggshell Finish/Vinyl Acrylic Latex
Primer: Benj. Moore Ultra Spec 500 Interior Latex Primer (N534)
PPG Speedhide Zero Interior Latex Primer 6-4900XI
S-W ProMar 200 Zero VOC Interior Latex Primer, B28-2600
First Coat: Benj. Moore Ultra Spec 500 Interior Latex Eggshell (N538)
PPG Speedhide Zero Interior Latex Eggshell 6-4310XI
S-W ProMar 200 Zero VOC Interior Latex Eg-Shell, B20-1900 Series
Second Coat: Benj. Moore Ultra Spec 500 Interior Latex Eggshell (N538)
PPG Speedhide Zero Interior Latex Eggshell 6-4310XI
S-W ProMar 200 Zero VOC Interior Latex Eg-Shell B20-1900 Series
a. Total DFT not less than: 3.8 mils

G. Interior Drywall to Receive Wallcovering

Primer: "Shield Z Mold and Mildew Proof Commercial Wallcovering Primer" made by Zinsser
Moore One Prep Wallpaper Primer WP-3001 by Insl-X
Multi-Purpose Interior/Exterior B51-450 by Sherwin Williams

H. Interior Painted Wood

Satin Finish/Latex
Primer: Benj. Moore Advance Waterborne Int. Alkyd Primer (790)
PPG Seal Grip Interior Primer/Finish 17-951
S-W Multi-Purpose Latex Primer/Sealer B51 Series
First Coat: Benj. Moore Advance Waterborne Int. Alkyd Satin (792)
PPG Speedhide Zero Interior Latex Satin, 6-4410XI
S-W ProMar 200 Zero VOC Interior Latex Eg-Shel, B20-1900 Series
Second Coat: Benj. Moore Advance Waterborne Int. Alkyd Satin (792)
PPG Speedhide Zero Interior Latex Satin, 6-4410XI
S-W ProMar 200 Zero VOC Interior Latex Eg-Shel, B20-1900 Series
a. Total DFT not less than: 4.0 mils

Semi-Gloss Finish/Latex
Primer: Benj. Moore Advance Waterborne Int. Alkyd Primer (790)
PPG Seal Grip Interior Primer/Finish 17-951
S-W Multi-Purpose Latex Primer/Sealer B51 Series
First Coat: Benj. Moore Advance Waterborne Int. Alkyd (793)
PPG Speedhide Zero Interior Semi-Gloss Latex, 6-4510XI
S-W ProMar 200 Zero VOC Interior Latex Semi-Gloss, B31-2600 Series
Second Coat: Benj. Moore Advance Waterborne Int. Alkyd (793)
PPG Speedhide Zero Interior Semi-Gloss Latex, 6-4510XI
S-W ProMar 200 Zero VOC Interior Latex Semi-Gloss, B31-2600 Series
a. Total DFT not less than: 3.8 mils

I. Concrete Floor Sealer: "Super Diamond VOX" water-based, low-VOC acrylic sealer, as manufactured by Euclid Chemical Company, or approved equal.

2.5 PIPING AND MECHANICAL EQUIPMENT EXPOSED TO VIEW (WHERE INDICATED TO BE PAINTED)

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.

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. Block Masonry Surfaces: Thoroughly clean off all grit, grease, dirt, mortar drippings or splatters, and other foreign matter. Remove nibs or projections from masonry surfaces. Fill cracks, holes or voids not filled under the "Masonry" Section, with Portland cement grout, and bag surface so that it has approximately the same texture as the adjacent masonry surface.

F. Testing for Moisture Content: Contractor shall test all masonry and drywall surfaces for moisture content using a reliable electronic moisture meter. Contractor shall also test latex type fillers for moisture content before application of top coats of paint. Do not apply any paint or sealer to any surface or to latex type filler where the moisture content exceeds seven (7) percent as measured by the electronic moisture meter.

G. 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

SECTION 101100

VISUAL DISPLAY SURFACES

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 visual display surfaces as shown on the drawings and/or specified herein, including but not necessarily limited to the following:

1. Custom tackable fabric-wrapped boards.

2. Magnetic/writable surface.

3. Frames and trim.

1.3 RELATED SECTIONS

A. Gypsum Drywall - Section 092900.

1.4 QUALITY ASSURANCE

A. Qualifications of Installers: For installation of visual display surfaces, 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. Installation Methods: The recommended installation methods of the manufacturer shall become the basis for acceptance or rejection of actual installation methods used in the work.

C. Manufacturer: Furnish all tackboards by one manufacturer for entire project.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's technical data and installation instructions for each material and component part, including data substantiating that materials comply with requirements.

B. Shop Drawings: Submit for each type of visual display surface. Include sections of typical trim members and dimensioned elevations. Show anchors, grounds, reinforcement, accessories, and installation details.

C. Samples: Submit full range of color samples for each type of visual display surface, trim and accessories required. Provide 12" square samples of sheet materials and 12" lengths of trim members for color verification after selections have been made.

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 TACKABLE SURFACING

A. Provide "Filzfelt" by Knoll, Unica Vaev Encoustic Panel or approved equal.

1. Core Thickness and Density: 2" thick, 6-7 pcf density.
2. Width: Custom.
3. Length: Custom.
4. Edge Profile: Square.
5. Corners: Square.
6. Mounting Type: Z-clip plates and wall bars.
7. Fabric: Guilford of Maine, color as selected by the Architect.
8. Flammability: Class A per ASTM E 84.

2.2 GLASS MARKER BOARDS

A. Fixed, Magnetic, Glass, Dry-Erase Marker Boards: Provide Wall2Wall as manufactured by Clarus.

1. Color/Finish: See Finish Schedule.

2.3 FABRICATION

A. Assembly: Provide factory-assembled tackboard units unless field-assembled units indicated.

B. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, balanced around center of board, as acceptable to Architect.

1. Provide manufacturer's standard vertical joint system between abutting sections of tackboard.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where visual display surfaces 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. Deliver factory-built tackboard units completely assembled in one piece without joints, whenever possible. Where dimensions exceed panel size, provide 2 or more pieces of equal length as acceptable to the Architect. When overall dimensions require delivery in

separate units, prefit at factory, disassembled for delivery, and make final joints at site. Use splines at joints to maintain surface alignment.

B. Install units in locations and mounting heights as shown on drawings and in accordance with manufacturer's instructions, keeping perimeter lines straight, plumb and level. Provide all grounds, clips, backing materials, adhesives, brackets, anchors, trim and accessories for complete installation.

C. Coordinate job-assembled units with grounds, trim and accessories. Join all parts with neat, precision fit.

3.3 ADJUST AND CLEAN

A. Verify accessories required for each unit properly installed and operating units properly functioning.

B. Clean units in accordance with manufacturer's instructions, breaking in only as recommended.

END OF SECTION

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. 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 the following:

1. Room identification signs.
2. Interior directional and door signage.
3. Fire egress, floor, and other signs required by Code.
4. Building identification.

1.3 RELATED SECTIONS

A. Exit signs - Division 26.

1.4 QUALITY ASSURANCE

A. For actual installation of the signage, 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 signage. 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. Fire egress, floor, and other signs required by Code shall be as follows:

1. Interior Panel Signs: Provide smooth sign panel surfaces constructed to remain flat under installed conditions within a tolerance of plus or minus 1/16 inch measured diagonally from corner to corner, manufactured from 0.050-inch aluminum sheet, framed. Comply with requirements indicated for finishes, colors, designs, shapes, sizes, and details of construction (as selected by the Architect).

2. Engraved Copy: Machine engrave letters, numbers, symbols, and other graphic devices into panel sign on face indicated to produce precisely formed copy, incised to uniform depth. Fill engraved copy with enamel.

3. Tactile Characters: Characters and Grade 2 Braille raised 1/32 inch above surfaces, in contrasting color.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where signage 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 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 101455
TRAFFIC AND REGULATORY SIGNAGE (SITE)

PART 1 – GENERAL

1.01 DESCRIPTION

A. This Section specifies requirements for site traffic and regulatory signs and supports.

B. The work includes:

1. The furnishing and installation of new signs and sign supports.
2. The removal of existing signs.

1.02 SUBMITTALS

A. Shop Drawings:

1. Shop Drawings of all signs and supports. Do not order material or begin fabrication until Engineer's approval has been obtained.
2. Show sizes and thicknesses of all members, types of materials, methods of construction and assembly, type of surface treatment, complete dimensions, hangers, brackets, anchorage, fasteners, relationship to surrounding work by other trades, shop finishes, sign designs, layouts, and lettering, and other pertinent details of fabrication and installation.

1.03 QUALITY ASSURANCE

A. The manufacturer shall have experience in the type of work required and a reputation for producing satisfactory work on time.

B. Deliver and store in a manner that prevents cracking, chipping, stress of the components, and damage.

PART 2 – PRODUCTS

2.01 ALUMINUM SIGN PANELS

A. Aluminum Sign Panel: Fabricated from flat aluminum sheeting, ASTM B209, Alloy 6061-T6 or Alloy 5052-H38, of the following thickness and mounting, unless otherwise specified:

Area of Sign (square feet)	Mounting	Thickness (Inches)
Less than or equal to 10	Single Post	0.080
Between 10 and 20	Two Posts	0.080
Between 6 and 25	Single Post (Top Mounted)	0.250

B. Sign supporting hardware shall be aluminum or stainless steel.

2.02 REFLECTIVE SHEETING

A. Reflective sheeting shall meet the requirements of AASHTO M 268.

1. Panel sheeting shall be Type II (Engineering Grade).
2. Legend sheeting shall be Type III (High Intensity).

B. Reflective sheeting shall be applied to properly treated base panels with mechanical equipment in a manner specified for the manufacture of traffic control signs by the sheeting manufacturer. Heat activated adhesive coating sheeting shall be pre-perforated.

1. No splices shall be allowed on sign panels.

C. When pressure sensitive adhesive coating reflective sheeting is used all sheeting splices and sign edges shall be sealed with materials recommended by and in a manner specified by the sheeting manufacturer.

1. Dry heat activated adhesive coated reflective sheeting when applied to aluminum shall be edge sealed as specified by the sheeting manufacturer.

D. Reflective sheeting shall be applied to properly treated base panels with mechanical equipment in a manner specified by the sheeting manufacturer.

E. The numerals shall be black, die-cut, pre-spaced, conforming to the detail on the Drawings. Numerals shall have a pre-coated, pressure-activated adhesive applied as recommended by the manufacturer of the reflective sheeting or be opaque black permanent inks applied on approved high intensity sheeting.

F. Treatment of Aluminum Sign Panels Prior to Application of Reflective Sheeting.

1. Degreasing:
   a. Vapor degreasing: By total immersion of the panel in a saturated vapor or trichloroethylene. Trademark printing shall be removed with lacquer thinner or controlled alkaline cleaning system.
   b. Alkaline degreasing: By total immersion of the panel in a tank containing alkaline solutions, controlled and titrated to the solution manufacturer's specification.
2. Rinsing: After satisfactory degreasing, the panels shall be thoroughly washed with running water.
3. Drying: The panel shall be thoroughly dried by use of a forced hot air dryer.
4. Metal shall not be handled between cleaning and etching operation and the application of reflective sheeting, except with devices or clean canvas gloves.
5. Metal shall not come in contact with greases, oils, or other contaminants prior to the application of reflective sheeting.

2.03 LEGENDS

A. Permanently Applied Legends:

1. Permanently applied legends shall be reflective or opaque sheeting applied directly to clean, dust-free background in a manner specified by the sheeting manufacturer.
2. Heat activated adhesive-coated material shall be applied only by mechanical means.
3. Finishes shall be as recommended by and applied in the manner specified by the sheeting manufacturer.
4. Legends shall be neatly cut.

B. Silk Screen Processed:

1. The legends shall be of the series and size specified in the AASHTO Manual for "Signing and Pavement Markings" (current edition), and the dimension and details of the letters in to each series shall be as specified in the U.S. Department of Transportation FHWA publication "Standard Alphabets for Highway Signs and Pavement Markings" (current edition), or as shown on the Drawings.

2.04 FASTENERS AND ANCHORS

A. The sign fabricator shall design a complete system of fastenings and anchorage devices for the various signs, as required for attachment to the various supporting structures. These may include concealed clip systems, face screws and epoxy adhesives. Wherever reasonably possible, fastenings and anchorage devices shall be fully concealed and shall be vandal proof. The Contractor shall provide safe and secure installations in strict conformance to the governing laws and building code.

2.05 SIGN SUPPORTS

A. Type A Sign support shall be 2-1/2” steel post; paint color shall be selected by the Architect.

PART 3 – EXECUTION

3.01 PROTECTION AND TEMPORARY COVERS

A. Completed sign panels shall be protected and maintained in good condition, free from dirt, scratches, hand marks or other blemishes. The panels shall be transported in a manner that prevents damage.

B. Subsequent to erection, if required by the Engineer, exterior signs shall be covered until the actual use is desired. Material used to temporarily cover any sign panel shall effectively conceal the message, be non-injurious to the panel, its finish, its structural integrity, and shall be of sufficient durability for the time period required.

3.02 INSTALLATION

A. Erection of all signs shall be performed by experienced sign erectors. Signs shall be installed true, plumb, and level, located where shown on the Drawings or as required by the Engineer. No field cutting of any sign work will be allowed. Exercise extreme care in all handling and stacking of signs to avoid chipping.

B. All work shall be rigidly anchored to the supporting construction in accordance with the approved shop drawings.

3.03 CLEAN-UP

A. Surfaces of signs shall be cleaned as recommended by the sign manufacturer after installation.

B. All defective work shall be removed and replaced with work conforming to the specified requirements.

3.04 ERECTION OF POSTS

A. Posts specifically indicated on the drawings to be driven, shall be driven a minimum of four feet into firm ground.

B. Steel Posts shall be supported in a concrete base as detailed in the drawings.

C. The height of signs above ground surfaces shall meet Americans with Disabilities Act (ADA) requirements.

END OF SECTION 101455

SECTION 102813

TOILET 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. Electric hand dryers.
4. Diaper-changing stations.
5. Additional toilet accessories as scheduled on the drawings.
6. 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. Toilet Partitions - Section 102113.

E. 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.

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 ACCESSORY SCHEDULE

A. Refer to drawings.

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. 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.

F. 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.

G. 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 105113

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

1. Wood lockers with plastic laminate finish.

2. Trim, closures, anchors and accessories.

1.3 RELATED SECTIONS

A. Carpentry - Section 062000.

B. Architectural woodwork - Section 064023.

C. Gypsum drywall - Section 092900.

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.

1.5 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of locker.

B. 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.

C. Submit locker numbering sequence to Owner for review during the shop drawing process. Copy Architect on transmittal.

D. Samples

1. Submit 6" x 6" samples of manufacturer's standard finish.

2. Full size of each hardware item, lock, number plate, hook, hinges, etc.

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 repairs and replacements necessary.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Provide Plastic Laminate Wood Lockers as manufactured by Hollman, Inc., or equal by Salsbury Industries, Ideal Products, Inc., Legacy Lockers or approved equal.

2.2 CUSTOM PLASTIC LAMINATE LOCKERS

A. Locker Frame: Tops, sides, and back shall be constructed of 5/8” high density thermo-fused melamine.

1. Expansion / contraction within +/- 1/16” per locker.

B. Visible Edges: Sealed with a 1.5 millimeter PVC edge banding to closely match locker doors

C. Locker Doors

1. Laminate: 5/8 inch high-industrial grade particle board core with .030 inch vertical grade high pressure Class II-B fire retardant plastic laminate.

2. Matching laminate applied to interior & exterior door face.

a. Door edges sealed with eased edge 1.5 mm PVC edge banding to closely match laminate.

D. Hardware

1. Number disk, 1-1/2” diameter flush mounted disc with 3/8” high contrast digits. US Block 1L font.

2. Coat Rod, 1” diameter recessed rod.

3. Coat Hook(s), 2-prong metal hooks.

4. Hinges: Nickel finished, concealed, heavy duty European steel allowing 110 degree door opening with lifetime warranty.

a. 4 hinges per door 60” H & over.
b. 3 hinges per door 36” – 59” H.
c. 2 hinges per door 35” H & under.

E. Locking System: Keyless 1 and Keyless 1 ADA.

F. Venting: 12 millimeter openings between door and top and bottom of locker and dividers on multiple opening frames provide continuous natural air flow.

2.3 LOCKER ROOM BENCHES

A. Manufacturer's standard units with laminated hardwood tops size as indicated on drawings. Furnish steel pedestal supports not more than 6'-0" o.c., with provisions for concealed fastening to floor and securing to bench. Furnish all anchorages. Apply manufacturer's standard clear coating to bench tops and baked enamel finish to pedestals.

2.4 FABRICATION

A. Locker shall be fabricated using doweled and glued assembly process.

B. Fabricate locker parts square, rigid and without warp, with the finished faces flat and free of scratches and chips.

C. Finish toe kick and wood base to match locker doors.

D. Machine all parts and attachment holes accurately and without chips and defects. Attach fasteners as standard with manufacturer.

E. Fabricate corners and fillers as required for installation.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where wood lockers 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 lockers at locations shown in accordance with manufacturer's instructions for plumb, level, rigid and flush installation after finish floor and painting have been completed.

B. Space fastenings 36" o.c. maximum and apply through back-up reinforcing plates where necessary to avoid metal distortion; conceal all fasteners.

C. Install trim and filler panels using concealed fasteners to provide flush, hairline joints against adjacent surfaces.

D. Install benches to comply with manufacturer's instructions in such a manner that they resist a 200 lb. load applied laterally to benches.

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 113100

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. As scheduled 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

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-switched, electrically-operated window treatment.

2. Field measurements of as-built conditions.

3. 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.

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 of self-lubricating, uv stabilized fiberglass reinforced nylon construction and tempered high carbon steel internal springs, designed for smooth, trouble-free operation, precise control, and uniform aesthetics. Galaxy geared or spring boost counter balance system to achieve < 6 lbs. constant pull forcesDrive 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.

D. 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.

2.2 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 Shade: Where black-out shades are indicated, shade cloth shall be "Equinox 0100 Series" opaque acrylic black-out 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.

2.3 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 manufacturers written instructions.

3.4 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 142600

LIMITED USE/ LIMITED APPLICATION (LULA) ELEVATOR

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Applicable provisions of the Conditions of the Contract and Division #1, General Requirements, govern work in this Section.

1.2 SECTION INCLUDES

A. The work of this Section consists of the following:

1. One elevator (LULA) with cab as shown on drawings.

1.3 RELATED SECTIONS

A. Electrical power and wiring to elevator controllers and car lights - Division 26.

1.4 DEFINITIONS

A. Defective Elevator Work: Operation or control system failures; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; the need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.

B. Product Data: Include capacities, sizes, performances, operations, safety features, finishes, and similar information.

C. Shop Drawings: Show plans, elevations, sections, and large-scale details indicating service at each landing, machine room layout, coordination with building structure, relationships with other construction, and locations of equipment and signals. Indicate variations from specified requirements, maximum dynamic and static loads imposed on building structure at points of support, and maximum and average power demands.

D. Samples: For exposed finishes of cars, hoistway doors and frames, and signal equipment; 3-inch square samples of sheet materials; and 4-inch lengths of running trim members.

E. Manufacturer Certificates: Signed by elevator manufacturer certifying that hoistway, pit, and machine room layout and dimensions, as shown on Drawings, and electrical service, including emergency generator, as shown and specified, are adequate for elevator system being provided.

F. Maintenance Manuals: Include operation and maintenance instructions, parts listing with sources indicated, recommended parts inventory listing, emergency instructions, and similar information. Include diagnostic and repair information available to manufacturer's and Installer's maintenance personnel. Submit for Owner's information at Project closeout as specified in General Conditions.

G. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements: In addition to New York City Building Code regulations, comply with applicable provisions in ASME A17.1, "Safety Code for Elevators and Escalators."

1. Accessibility Requirements: In addition to local governing regulations, comply with Section 4.10 in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines (ADAAG)." Section 407 in ICC A117.1.

1.6 COORDINATION

A. Coordinate installation of sleeves, block outs, and items that are embedded in concrete or masonry for elevator equipment. Furnish templates and installation instructions and deliver to Project site in time for installation.

B. Furnish well casing and coordinate delivery with related excavation work.

C. Coordinate locations and dimensions of other work relating to hydraulic elevators including pit ladders, sumps, and floor drains in pits; entrance sub-sills; and electrical service, electrical outlets, lights, and switches in pits and machine rooms.

1.7 WARRANTY

A. Special Manufacturer's Warranty: Written warranty, signed by manufacturer agreeing to repair, restore, or replace defective elevator work within specified warranty period.

1. Warranty Period: 12 months from date of Substantial Completion.

1.8 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance service by skilled employees of the elevator Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper elevator operation at rated speed and capacity. Provide parts and supplies as used in the manufacture and installation of original equipment.

1. Perform maintenance, including emergency callback service, during normal working hours.

2. Include 24-hour-per-day, 7-day-per-week emergency callback service.

a. Response Time: Two hours or less.

B. Continuing Maintenance Proposal: Offer a continuing maintenance proposal from Installer to Owner, in the form of a standard yearly 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 MANUFACTURERS

A. Provide LULA lift Orion by Savaria Concord Lifts, Symmetry Elevating Solutions, Garaventa, or approved equal.

2.2 ELEVATOR

A. Drive/Motor: Counterweight geared traction drive with slack cable safety device. Geared motor 1:1 sheave, three 3/8" diameter elevator traction cables, rope wedge sockets.

B. Power Supply: Coordinate with Division 26.

C. Capacity: 1,400 lbs.

D. Speed: 30 fpm.

E. Clear Inside Dimensions: As indicated on the drawings.

F. Travel Distance: As indicated.

G. Stops: Front/back door configuration.

2.3 MATERIALS AND COMPONENTS

A. Finishes

1. Floor and Finish: Plywood floor, finish as selected by the Architect.

2. Car Wall Panels: Flush, formed-metal construction; fabricated from stainless steel sheet.

3. Fabricate car with recesses and cutouts for signal equipment.

a. Finish for Signal Equipment: Satin stainless steel.

4. Car Doors: Horizontal sliding, automatic operation, 36" w. x 84" h., flush, hollow-metal construction; fabricated from stainless steel sheet.

5. Hoistway Doors: Horizontal sliding, automatic operation, flush, hollow-metal construction; fabricated from stainless steel sheet.

6. Sills: Extruded or machined metal, with grooved surface, ¼" thick.

7. Car Ceiling: Flush metal panels with recessed, incandescent downlights in the center of each panel.

B. Operating Features:

1. Car Operating Panel: Brushed stainless steel or brushed bronze panel with illuminated automatic controls, keyed light switch, emergency stop switch and alarm button.

2. Hall Stations: Brushed stainless steel or brushed bronze panel with illuminated button and key lock provided at each landing.

3. Car Door(s): Fully automatic, side opening, sliding car door with electromechanical interlocks, obstruction sensor, and automatic re-open system.

4. Hoistway Doors: 1-1/2 hour fire rated, fully automatic, side opening, sliding hoistway doors with two side opening panels in steel frame with electromechanical interlocks.

5. Handrail: Stainless steel or bronze.

6. Pit switch and car top run/stop switch.

7. Car top inspection station with UP and DOWN test switches, emergency stop, light outlet and battery backup emergency light and alarm with illuminated alarm switch in car.
8. Automatic homing to the lowest floor.
9. Slack rope safety.
10. Anti-creep device.
11. Overspeed governor.
12. Dual direction leveling.
13. Upper and lower terminal limit.
14. Pump run timer.
15. Pit clearance device.
16. Automatic battery powered and manual emergency lowering control devices.
17. Minimum pressure switch.
18. Maintenance stop blocks.
19. Phase 1 fire service.
20. Hall lanterns with chime.
21. Recessed telephone cabinet (brushed stainless steel).

C. Fire-Protection Rating: One hour. Door and frame assemblies shall comply with NFPA 80 and be listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction based on testing at as close-to-neutral pressure as possible according to NFPA 252.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine all surfaces and contiguous elements to receive work of this section and correct, as part of the Work of this Contract, any defects affecting installation. Commencement of work will be construed as complete acceptability of surfaces and contiguous elements.

3.2 EXAMINATION

A. Examine elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance. Verify critical dimensions and examine supporting structure and other conditions under which elevator work is to be installed. Proceed with installation only after unsatisfactory conditions have been corrected.

1. For the record, prepare a written report, endorsed by Installer, listing dimensional discrepancies and conditions detrimental to performance.

3.3 INSTALLATION

A. Welded Construction: Provide welded connections for installing elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS standards for workmanship and for qualifications of welding operators.

B. Install piping above the floor, where possible. Where not possible, install underground piping in Schedule 40 PVC pipe casing assembled with solvent-cement fittings or cover underground piping with permanent protective wrapping before backfilling.

C. Lubricate operating parts of systems as recommended by the manufacturer.

D. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with cars. Where possible, delay installation of sills and frames until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.

E. Leveling Tolerance: 1/4 inch, up or down, regardless of load and direction of travel.

F. Set sills flush with finished floor surface at landing. Fill space under sill solidly with non-shrink, non-metallic grout.

3.4 FIELD QUALITY CONTROL

A. Acceptance Testing: On completion of elevator installation and before permitting use either temporary or permanent of elevators, perform acceptance tests as required and recommended by ASME A17.1 and by governing regulations and agencies.

B. Advise Owner, Architect, and authorities having jurisdiction in advance of dates and times tests are to be performed on elevators.

3.5 DEMONSTRATION

A. Instruct Owner's personnel in proper use, operations, and daily maintenance of elevators. Review emergency provisions, including emergency access and procedures to be followed at time of operational failure and other building emergencies. Train Owner's personnel 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's personnel present and before date of Substantial Completion. Determine that operation systems and devices are functioning properly.

END OF SECTION

SECTION 210000 - FIRE PROTECTION GENERAL REQUIREMENTS

PART 1 GENERAL

1.1 DESCRIPTION

A. All work under this Section shall comply with the requirements of General Conditions, Supplemental Conditions, Special Conditions and Division 1 - General Requirements, and shall include all Sections of Division 21 and shall apply to all Work specified, indicated in the Drawings, and as required to furnish a complete installation of mechanical systems for the Project. Review all Sections of the Specifications for related work and coordinate the work of this Section with all other Sections.

B. Furnish all labor, services, materials, tools, equipment, appliances, facilities, transportation and incidental work and appurtenances required to furnish a complete and properly operating system.

C. The Contractor shall refer to the architectural interior details, floor plans, elevations, and the structural and other Contract Drawings and shall coordinate the work with that of the other trades to avoid interference. The plans are diagrammatic and show the general arrangement of the conduit, panels, transformers and equipment. All dimensions and existing conditions shall be the responsibility the Contractor. Before proceeding with work check and verify all dimensions.

D. The Contractor shall assume all responsibility for fitting of materials and equipment to other parts of equipment and structure. Make adjustments that may be necessary or as requested, in order to resolve space problems, preserve headroom, and avoid architectural openings, structural members and work of other trades. Where existing pipes, conduits and/or ducts prevent installation of new work as indicated, relocate, or arrange for relocation with the applicable trades, existing pipes, conduits and/or ducts.

E. Where the project involves interface with existing building and site systems, the Consultant has used reasonable care to identify existing utilities and services. The Contractor is responsible to thoroughly familiarize themselves with existing conditions and be aware that in some cases information is not available i.e. concealed conditions, which exist in the existing building affected by this work.

F. Documents do not represent to show or list every item to be provided. When an item not shown or listed, is necessary for proper operation of the system and/or equipment, the Contractor shall provide the item which will allow the system to function properly at no increase in Contract Sum.

G. Work shall include, but shall not be limited to, the following:

1. Tie-ins to the existing fire protection system.
2. Relocation of existing systems which interfere with new construction.
3. Removal of existing piping, devices, equipment and appurtenances, to be abandoned.
4. Coordinate maintenance of existing services during construction with Owner.
5. Special coordination of chases and shafts.
6. Hoisting and rigging required to complete work of this section.
7. Sleeves, inserts and hangers.
8. Equipment bases and supports.

9. Vibration isolators, and seismic restraints.
10. Motors.
11. Wet-Pipe Sprinkler Systems
12. Dry-Pipe Sprinkler Systems
13. Preaction Sprinkler Systems
14. Combined Dry-Pipe and Preaction Sprinkler Systems
15. Deluge Fire-Suppression Sprinkler Systems
16. Water Spray Fixed Systems
17. Antifreeze Sprinkler Systems
18. Foam-Water Systems
19. Fire Suppression Standpipes and Hose Connections
20. Facility Fire Hydrants
21. Carbon-Dioxide Fire-Extinguishing Systems
22. Clean-Agent Fire-Extinguishing Systems
23. Wet-Chemical Fire-Extinguishing Systems
24. Dry-Chemical Fire-Extinguishing Systems
25. Fire Pumps
26. Prime painting.
27. Equipment and major component identification.
28. Instruction manual and start up instructions.
29. Testing and balancing.
30. Commissioning.
31. Cleaning.

H. Related work specified elsewhere: The following work, unless otherwise noted is not included in this section shall be performed in other sections:

1. Plumbing and Piping. Division 22
2. Mechanical HVAC Equipment. See Division 23.
3. Integrated Automation. See Division 25
4. Electrical Power and Wiring. Division 26
5. Electronic Safety and Security. See Division 28
6. Excavation and backfill.
7. Concrete work, including concrete housekeeping pads and other pads and blocks for vibrating and rotating equipment.
8. Cutting and patching of masonry, concrete, tile and other parts of structure, with the exception of drilling for hangers and providing holes and openings in metal deck.
9. Flashing of wall and roof penetrations.
10. Installation of access panels in floors, walls, furred spaces or above ceilings
11. Partitions and Painting (except as specifically indicated) See Division.
12. Structural supports necessary to distribute loading from equipment to roof or floor, except as specified herein.
13. Paving

1.2 QUALITY ASSURANCE

A. General:

1. All equipment and accessories shall be the product of a manufacturer regularly engaged in its manufacturer.
2. All equipment and accessories shall be new and free from defects.
3. Supply all equipment and accessories in compliance with the applicable standards listed in this Section and with all applicable National, State and Local Codes.
4. All items of a given type shall be the product of the same manufacturer.

5. Install work by craftsmen skilled in trade involved and by apprentices as indicated in the general conditions. Rough work will be rejected.
6. The subcontractor must, within the last five years, prior to the bid opening, have successfully completed in a timely fashion at least three projects similar in scope and type to the required work.

B. Requirement of regulatory agencies:

1. In accordance with requirements of Division 1 and as specified herein.
2. Nothing in the Drawings or Specifications shall be construed to permit Work not conforming to applicable laws, ordinances, rules or regulations.
3. When Drawings or Specifications exceed requirements of applicable laws, ordinances, rules or regulations, Drawings and Specifications take precedence.
4. It is not the intent of Drawings and Specifications to repeat requirements of codes except where necessary for completeness or clarity.
5. If any of the requirements of the above are in conflict with one another, or with the requirements of these specifications, the most stringent requirements shall govern.

1.3 APPLICABLE PUBLICATION

A. Materials and equipment shall be manufactured, installed and tested as specified in latest editions of applicable publications, standards, rulings and determinations of:

1. Local and state building fire protection, plumbing, mechanical, electrical, and health department codes.
2. American Society of Plumbing Engineers (ASPE)
3. American Water Works Association (AWWA)
4. American Society of Mechanical Engineers (ASME)
5. American Welding Society (AWS)
6. American National Standards Institute (ANSI).
7. American Society of Testing and Materials (ASTM).
8. Underwriter's Laboratories (UL).
9. National Fire Protection Association (NFPA).
10. Occupational Safety and Health Act (OSHA)

B. All materials and equipment shall be listed by Underwriters" Laboratories (UL), and approved by ANSI, and ASTM for intended service.

C. Most recent editions of applicable specifications and publications of the following organizations form part of these Contract Documents.

1. American National Standards Institute (ANSI)
2. American Water Works Association (AWWA)
3. American Society of Mechanical Engineers (ASME)
4. American Welding Society (AWS)
5. American Society of Testing and Materials (ASTM)
6. American Society of Plumbing Engineers (ASPE)
7. Underwriter's Laboratories (UL).
8. National Fire Protection Association (NFPA).
9. Occupational Safety and Health Act (OSHA)
10. Factory Mutual Association (FM).
11. National Electric Code (NEC)
12. Environmental Protection Agency (EPA)
13. National Bureau of Standards (NBS)

14. Owner's Insurance Underwriter.
15. Specific reference is made to following NFPA codes which contain an exceptionally high quantity of mechanical, electrical, and fire protection requirements.
16. No. 13- Installation of sprinkler systems
17. No. 14- Installation of standpipe and hose systems
18. No. 20- Installation of centrifugal fire pumps.
19. No. 30- Combustible Liquids
20. No. 45- Fire Protection for Laboratories
21. No. 70- National Electric Code
22. No. 72D- Proprietary Protective Signaling Systems
23. No. 72E- Automatic Fire Detectors

1.4 DEFINITIONS

A. "Provide" means "furnish and install", complete, the specified material, equipment or other item and perform all required labor to make a finished and properly operational installation.

B. "Furnish" means to purchase and deliver to project site complete with all appurtenance and support. "Install" means to unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project

C. "Consultant" means "Prime Design Consultant". An individual or organization engaged by the owner or the architect to render professional engineering consulting services complementing or supplementing the architect's services concerning the content of the Mechanical, Electrical, Plumbing & Fire Protection sections of specifications.

D. "Owner" means the individual or entity with whom Contractor has entered into the Agreement for whom the Work is to be performed

E. "Construction Manager Advisor" or "CMA" means the Construction Manager that provides services to advise the Owner and Architect on design and materials decisions during the design and document development process. The CMA coordinates the entire design process using his skills and knowledge of construction to clarify cost and time considerations of design decisions, to advise on feasibility of single, multiple-contract or fast-track delivery systems, recommend the construction process, and to handle the bidding and award, as well as to manage the construction of the Project.

F. "Construction Manager Constructor" or "CMC" means the Construction Manager that in addition to acting as an advisor to the Owner during a design period, assumes responsibility for the construction of the Project. The CMC become contractually bound to provide the labor and material for the Project. The CMC may also serve as administrator of multiple prime contract construction; however, some states prohibit that practice.

G. General Contractor/ Prime Contractor means the contractor who contracts with a property owner and, in turn, employs a subcontractor or subcontractors to perform some of all of the work.

H. "Contractor" or "Subcontractor" means the trade contractor responsible for the work in this Division of the specification.

I. "Owner's Representative" means the Consultant, Engineer, or other Specialty Consultant retained by the Owner.

J. "RFI" means "Contractor's Request for Information".

K. "Above Grade": Not buried in the ground and not embedded in concrete slab on ground.

L. "Accessible": Ability to perform recommended maintenance without removal of services or equipment and requiring no special platforms.

M. "Actuating" or "Control" Devices: Automatic sensing and switching devices such as thermostats, pressure, float, electro-pneumatic switches and electrodes controlling operation of equipment.

N. "Below Grade": Buried in the ground or embedded in concrete slab on ground.

O. "Concealed": Embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures. In general, any item not visible or directly accessible.

P. "Connect": Complete hook-up of item with required service.

Q. "Exposed": Not installed underground or "concealed."

R. "Indicated," "Shown" or " "Noted": As indicated, shown or noted on Drawings or Specifications.

S. "Install": To erect, mount and connect complete with related accessories.

T. "Piping": Pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation, and related items.

U. "Reviewed," "Satisfactory" or "Directed": As reviewed, satisfactory, or directed by or to Architect/Engineer/Owner.

V. "Rough-In": Provide all indicated services in the necessary arrangement suitable for making final connections to fixture or equipment.

W. "Shall": An exhortation or command to complete the specified task.

X. "Similar" or "Equal": Of base bid manufacture, equal in materials, weight, size, design, and efficiency of specified products.

Y. "Supply": To purchase, procure, acquire and deliver complete with related accessories.

Z. "Typical" or "Typ": Exhibiting the qualities, traits, or characteristics that identify a kind, class, number, group or category. Of or relating to a representative specimen. Application shall apply to all other similarly identified on plan or detail.

AA. "Will": A desire to complete the specified task. Allows some flexibility in application as opposed to "Shall."

BB. "Wiring": Raceway, fittings, wire, boxes and related items.

CC. "Work": Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.

DD. Reference by abbreviation may be made in the specifications and the Contract Drawings for Mechanical and Electrical Work in accordance with the following list:

1. HVAC Heating, Ventilating and Air Conditioning
2. GC General Contractor
3. USS United States Standards
4. ASTM American Society of Testing Materials
5. ASA American Standards Association
6. ADA: Americans with Disabilities Act.
7. ANSI: American National Standards Institute.
8. HP: Horsepower.
9. ICEA: Insulated Cable Engineers Association
10. IEEE: Institute of Electrical and Electronic Engineers.
11. NEMA: National Electrical Manufacturers' Association.
12. NETA: National Electrical Testing Association, Inc.
13. NFPA: National Fire Protection Association.
14. OSHA: Occupational Safety and Health Act.
15. ABS: Acrylonitrile-butadiene-styrene plastic.
16. CPVC: Chlorinated polyvinyl chloride plastic.
17. PE: Polyethylene plastic.
18. PVC: Polyvinyl chloride plastic.
19. EPDM: Ethylene-propylene-diene terpolymer rubber.
20. NBR: Acrylonitrile-butadiene rubber.
21. UBC: Uniform Building Code.
22. UL: Underwriters' Laboratories,

1.5 SCOPE

A. Perform work and provide material and equipment as shown on the drawings and/or as specified and/or as indicated in this section of the specifications. Completely coordinate all work of this section with work of other trades and provide a complete and fully functional installation

B. Drawings and Specifications form complimentary requirements; provide work specified and not shown, and work shown and not specified as though explicitly require by both. Although work is not specifically shown or specified, provide supplementary or miscellaneous items, appurtenances, devices and materials obviously necessary for sound, secure and complete installation.

C. Give notices, file plans, obtain permits and licenses, pay fees and back-charges, and obtain necessary approvals from authorities that have jurisdiction as required to perform work in accordance with all legal requirements and with Specifications, Drawings, Addenda and Change Orders, all of which are part of Contract Documents.

D. Contractor shall be responsible with obtaining all the final inspection as required by Local Code and ordinances.

1.6 CONTRACT DOCUMENTS

A. Listing of Documents does not limit responsibility of determining full extent of work required by these Contract Documents. Refer to the Consultant's, Fire Protection, Plumbing, Electrical, HVAC, Structural, Site Utility and all other drawings and other sections that types of and work of other trades with which work of this section must be coordinated

B. Except where modified by a specific notation to the contrary; it shall be understood that the indication and/or description of any item, in the drawings or specifications or both, carries with it the instruction to furnish and install the item, regardless of whether or not this instruction is explicitly stated as part of the indication or description.

C. Items referred to in singular number in Contract Documents shall be provided in quantities necessary to complete work.

D. Drawings are diagrammatic. They are not intended to be absolutely precise; they are not intended to specify coordinated routings and component. The purpose of the document is to indicate systems concept, the main components of the systems, and the approximate geometric relationships. Based on the systems concept, the main components and the approximate geometrical relationships, the contractor shall provide all other components and materials necessary to make the systems fully complete and operational

E. Information and components shown on riser diagrams, but not shown on plans, and vice versa, shall apply and be provided as if expressly required on both

F. Data that may be furnished electronically by the Consultant is diagrammatic. Such electronically furnished information is subject to the same limitation of precision as heretofore described. If furnished, such data is for convenience and generalized reference, and shall not be substitute for Consultant's sealed or stamped construction documents.

1.7 ELECTRIONIC MEDIA FILES

A. Construction drawings for this project have been prepared utilizing AutoCAD 2013.

B. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.

C. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Release" form provided by Buro Happold.

D. The electronic contract documents can be used to assist in the preparation of shop drawings and as-built drawings however the electronic media files obtained from Buro Happold are for reference only. The information may not be used in whole or in part for any other project.

E. The drawings prepared for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.

F. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.

G. The information is provided to expedite the project and assist the Contractor with no guarantee by Buro Happold as to the accuracy or correctness of the information provided. Buro Happold accepts no responsibility or liability for the Contractor's use of these documents.

1.8 REVIEW OF CONTRACT DOCUMENTS AND SITE

A. With the submission of his bid, Contractor shall give written notice to the Owner of any materials or apparatus believed inadequate or unsuitable, in violation of laws, ordinances, rules or regulations of Authorities having jurisdiction, and any necessary items of work omitted. In the absence of such written notice it is mutually agreed that the Contractor has included the cost of all required items in his proposal for a complete project.

B. Contractor shall acknowledge that he has examined the Plans, Specifications and Site, and from his own investigations he has satisfied himself as to the nature and location of the work; the general and local conditions, particularly those bearing upon transportation, disposal, handling and storage of materials; availability of labor, water, electric power, roads and uncertainties of weather; the conformation and condition of the ground; the character, quality and quantity of surface and subsurface materials to be encountered; the character of equipment and facilities needed preliminary to and during the execution of the work; all federal, state, county, township and municipal laws, ordinances and regulations particularly those relating to employment of labor, rates of wages, and construction methods; and all other matters which can in any way affect work or the cost thereof under this Contract. Any failure by the Contractor to acquaint himself with the available information concerning these conditions will not relieve him from the responsibility for estimating properly the difficulty or cost of successfully performing the work.

C. The location and elevation of the underground utilities, such as sewers, electrical power, water piping, steam and steam condensate return piping, conduit, etc., is as exact as can be determined from available information and its accuracy cannot be guaranteed. Exact location and elevation of these services shall be verified prior to excavation or installation of any portion of the work indicated. Exercise special care when excavating at or near the general location of underground utilities to avoid damage to the utility services. The Contractors is responsible to insure worker safety.

D. The contractor shall also acknowledge having been to the site and examined conditions under which work must be performed including preparatory work done under other Sections or other Contracts or by the Owner. Report conditions to the Consultant. Do not proceed until defects have been corrected and conditions are satisfactory. Commencement of work shall be construed as complete acceptance of existing conditions and preparatory work.

E. Owner assumes no responsibility for any understanding or representation made during or prior to the negotiation and execution of this Contract unless such understanding or representations are expressly stated in the Contract, and the Contract expressly provides that the responsibility, therefore, is assumed by the Owner.

1.9 DISCREPANCIES IN DOCUMENTS

A. Where Drawings or Specifications conflict or are unclear, advise the Consultant in writing before award of Contract. Otherwise, Consultant's interpretation of the Contract documents shall be final, and no additional compensation shall be permitted due to discrepancies or ambiguousness thus resolved.

B. Where Drawings or Specifications do not coincide with manufacturer's recommendations, or with applicable codes and standards, alert the Consultant in writing before installation. Otherwise, make changes in installed work as the Consultant requires within Contract Price.

C. If the required material, installation, or work can be interpreted differently from drawing to drawing, or between drawings and specification, this contractor shall provide material, installation, or work which is of higher standard.

D. It is the requirement of these documents to have contractor provide systems and components that are fully complete and fully operational and fully suitable for intended use. There may be situations in the documents where insufficient information exists to precisely describe a certain component or subsystem, or the routing of the component or its coordination with other building elements. In cases such as this, where the contractor has failed to notify the Consultant of the situation in accordance with paragraph (A) above, the contractor shall provide specific component or subsystem with all parts necessary for the intended use, fully complete and operational, and installed in workmanlike manner either concealed or exposed per the design intent.

E. In cases covered by paragraph (D) above, where the contractor believes he needs the engineering guidance, he shall submit a sketch identifying his proposed solution and the Consultant shall review, note if necessary, and approve the sketch.

1.10 MODIFICATION IN LAYOUT

A. Fire Protection, Plumbing, Electrical and HVAC Drawings are diagrammatic. They indicate general arrangements of mechanical and electrical systems and other work. They do not show all offsets required for coordination nor do they show exact routings and locations needed to coordinate with structure and other trades to meet the Consultant's requirements

B. In order to obtain the Architect's desired aesthetics in spaces used by building occupants; prior to installation of visible materials, finishes and equipment (including access panels, review Consultant's Drawings for desired locations and where not definitely indicated, request information from the Architect/Consultant.

C. Check Contract Drawings, as well as Shop Drawings, of all subcontractors to verify and coordinate spaces in which work of this section will be installed

D. Maintain maximum headroom at all locations. All conduit, piping, duct and associated components to be as tight to underside of structure as possible.

E. Make reasonable modifications in layout and components to prevent conflict with work of other trades and to coordinate according to Paragraphs A,B,C,and D above. Systems shall be run in an organized and rectilinear fashion.

F. Where conflicts or potential conflict exists and engineering guidance is desired, submit sketch of proposed resolution to the Consultant for review and approval

1.11 RFI'S

A. If the RFI is a request to resolve a conflict or a un-clarity, or a request for additional detail, Contractor's RFI shall include a sketch or equivalent description of Contractor's proposed solution, in accordance with paragraph 1.9(E) above

1.12 PROJECT COMMUNICATION

A. The specification references communication and submittal of information and documents by the Contractor to the Engineers of Record and CM or visa versa. In all cases such communication shall be submitted to the CM who will review it before forwarding to the relevant party for review and response.

B. If the information provided is not in conformance with the specification the CM shall return it to the relevant Contractor for re-submission. The time taken for this process shall be factored into all work schedules and submissions.

1.13 MEASUREMENTS

A. Contractor shall base all his measurements, both horizontal and vertical from established benchmark. All work shall agree with these established lines and levels. He shall verify all measurements at site; and check the correctness of same as related to the work.

1.14 MATERIALS AND WORKMANSHIP

A. Materials shall be new, meet detailed requirements of the Contract Documents and be identifiable as being specified or substitute products.

B. Materials which do not conform to the requirements of the Contract Documents, are not equal to approved samples or are unsatisfactory or unsuited to the purpose for which they are intended, will be rejected.

C. All work shall be performed in the best and most workmanlike manner by tradesmen skilled in their respective trades and properly licensed.

D. All equipment shall be installed in accordance with the recommendation of the manufacturer.

E. Defective work, whether the result of poor workmanship, use of defective materials, damage through carelessness, or other cause shall be removed within ten (10) days after written notice is given by the Owner's Representative and the work shall be re-executed by the Contractor. The fact that the Owner's Representative may have previously overlooked such defective work shall not constitute total or partial acceptance of it.

F. In no case shall a Bidder base his bid on a class of material or workmanship less than that required by the contract documents nor the governing codes and ordinances.

1.15 CHECKING AND TESTING EQUIPMENT BY CONTRACTORS AND MANUFACTURER'S REPRESENTATIVE

A. All equipment shall be installed in strict accordance with manufacturer's instructions. During construction request supervisory assistance from equipment manufacturer's representatives so the equipment will be correctly installed. After installation, request the Owner's Representative to inspect and see the equipment is in proper working order.

B. Manufacturer's representative shall review the overall system design relative to the proper application of his equipment in the particular system. He shall note conduit, wiring, control, location, and other relevant relationships, and furnish appurtenances necessary for satisfactory operation.

C. Before final payment is issued the following shall be complete:

D. The Contractor's representative shall submit to the CM a signed statement certifying:

1. The equipment is properly installed and ready for operation
2. The owner's maintenance representatives have been thoroughly trained
3. Maintenance and operation manuals issued and accepted by the Owner's Representative.

1.16 SUBMITTALS

A. This paragraph supplements Division 1.

B. Definitions:

1. Shop Drawings are information prepared by the Contractor to illustrate portions of the work in more detail than shown in Contract Documents.
2. Coordination Drawings are detailed, large scale layout Shop Drawings showing HVAC, Electrical, Plumbing and Fire protection work superimposed in order to identify conflicts and ensure inter-coordination of Electrical, Mechanical, Plumbing, Fire Protection, Structural and other work.

C. Submittal Cover Sheet

1. Shop drawing submittal for each product shall include the copy of following cover sheet completely filled out. Incomplete or incorrect cover sheet submittal shall constitute reason for rejection.
2. Shop drawings shall be submitted according to specification section with a separate cover sheet completed for each product, rather than one cover sheet for multiple products, whether or not supplied by one manufacturer or vendor.
3. In order to maintain the shop drawing review schedule described hereafter, it is important that all submittals include a completed submittal cover sheet for each type of equipment submitted. This requirement will be enforced by the engineer.

SHOP DRAWING COVER SHEET		
PROJECT CONTRACTOR		
DIVISION NO: SECTION NO:		
DESCRIPTION:		
CONTRACT DRAWING REFERENCE NO:		
EQUIPMENT TAG:		
SUBMISSION (CIRCLE ONE): I II III IV		
DATE:		
INFORMATION AND CHECKLIST	REPLY	COMMENTS
4. Contractor's Log # ID		
5. Name, address, and phone number of supplier		
6. Are all specified or scheduled items included and exactly match	Yes No	

	scheduled/specified items.		
7.	Is this item a substitution?	Yes No	
8.	Are deviations clearly identified?	Yes No	
9.	Does this equipment fit space shown on construction documents, coordination drawings, and actual field conditions?	Yes No	
10.	Has support, erection, weights, and installation been coordinated with all trades?	Yes No	
11.	Does the proposed installation void warranties and/or violate UL or code requirements?	Yes No	
12.	Does this material/equipment add expense to any other trade or project costs?	Yes No	
13.	Does equipment require interface with other trades? Lists divisions and specifics requiring coordination?	Yes No	
14.	Is control interface coordinated?	Yes No	
15.	List electrical characteristics (V/Ph/A)	Yes No	

D. Submittals procedure and format

1. Identify each item by manufacturer, brand, trade name, number, size, rating, or whatever other data is necessary to properly identify and check materials and equipment.
2. Identify each submittal item by reference to Specification Section paragraph in which item is specified, or Drawing and Detail number, identify deviations, if any.
3. Organize submittals in same sequence as they appear in Specification Sections, articles or paragraphs.
4. Shop Drawings shall show physical arrangement, construction details and finishes:
5. Drawings shall be drawn to scale and dimensioned where applicable.
6. Catalog cuts and published material shall be included to supplement scale drawings.
7. Internal wiring diagrams of equipment shall show wiring as actually furnished for this project, with all optional items clearly identified as included or excluded. Clearly identify external wiring connections. Identify and obliterate superfluous material.
8. Submittal literature, drawings and wiring diagrams shall be specifically applicable to this Project and shall not contain extraneous material or optional choices. Clearly mark literature to indicate the proposed item. Submittals shall include, but not be limited to those items listed in individual Sections.
9. Include all physical and performance data, including materials, manufacturer's names, model numbers, weights, sizes, capacities, performance curves, finishes, colors, accessories, installation instructions, and all other data required to completely describe equipment and to indicate complete compliance with Specifications and Drawings.
10. Include with complete submittals above, complete, large scale, dimensioned Shop Drawings, certified by manufacturer, of all major equipment.

11. Time Schedules for Submission and Ordering: The Contractor shall prepare, review and coordinate his schedule of submissions carefully, determining the necessary lead time for preparing, submitting, checking, ordering and delivery of all materials and equipment for timely arrival. The Contractor shall be responsible for conformance with the overall construction schedule.
12. Submittals shall be reviewed for general compliance with Specifications only. The Contractor shall be responsible for deviations from the Drawings or Specifications and for errors or omissions of any sort in submittals.
13. The Contractor shall add and sign the following paragraph on all equipment and materials submitted for review:
14. "It is hereby certified that the equipment, material shown and marked in this submittal is that proposed to be incorporated into the project; is in compliance with the Contract Drawings and Specifications and can be installed in the allocated spaces."
15. Failure to add the above written statement for compliance shall result in return of submittals to be reviewed.
16. The Contractor shall verify dimensions of equipment and be satisfied per Applicable Code Requirements for fit prior to submitting Shop Drawings for approval.
17. Submit to the Consultant a complete set of final drawings, specifications and hydraulic calculations approved by the Fire Marshal having jurisdiction.
18. Hydraulic calculations and final layout shall be the responsibility and prepared by the Fire Protection Contractor.
19. For any material specified to meet Underwriters' Laboratories, Inc. (UL) or trade standards, furnish the manufacturer's or vendor's certification that the material furnished for the work does in fact equal or exceed such Specifications.
20. Submit on all materials and equipment even if they are as specified or shown on the Drawings.
21. Equipment Floor Plans: After approval of material is secured, prepare a floor plan of each electrical equipment closet enclosures and room drawn to, scale of 1/2 inch equals 1 foot, and submit for approval in the same manner as for Shop Drawings. The layout drawings shall be to exact scale, and indicate location of all fire protection equipment.
22. Resubmittals shall include written response to each item in review of previous submittal.

E. Acceptable Manufacturers: The Consultant's mechanical/electrical design for each product is based on the single manufacturer listed in the schedule or shown on the drawings. In Part 2 of the specifications certain Alternate Manufacturers are listed as being acceptable. These are acceptable only if, as a minimum, they:

1. Meet all performance criteria listed in the schedules and outlined in the specifications.
2. Have identical operating characteristics to those called for in the specifications. For example, a two stroke diesel generator will not be acceptable if a four stroke is specified.
3. Fit within the available space it was designed for, including space for maintenance and component removal, with no modification to either space or product. Clearances to walls, ceilings and other equipment will be least equal to those shown on the design drawings. The fact that a manufacturer's name appears as acceptable shall not be taken to mean that the Consultants have determined that the manufacturer's products will fit within the available space. This determination is solely the responsibility of the contractor.
4. Products must adhere to all Consultant's considerations including, but not limited to: being of same color as the product scheduled or specified, fitting within Consultant's enclosures and details, and for sprinklers, diffusers, lighting and plumbing fixtures - being the same size and physical appearance as scheduled or specified products.
5. The proposed substitution shall meet performance and quality of scheduled equipment, whether it requires additional accessories or not.
6. There is no increase in Contract Sum and this Contractor shall pay for any additional work required by other trades as a result of the substitution.

F. Required Use of Acceptable Manufacturers on his Project: Substitution of products other than those of the Acceptable Manufacturers specified herein shall not be made. Only the specified items or the comparable product by one of the specified Alternate Manufacturers shall be submitted. Products by other manufacturers shall not be used on this project.

G. Deviations:

1. Concerning deviations other than substitutions, proposed deviations from Contract Documents shall be requested individually in writing whether deviations result from field conditions, standard shop practice or other cause. Submit letter with transmittal of shop drawings, which flags deviation to the attention of the Consultants.
2. Without letters flagging the deviation to the Consultants, it is possible that the Consultants may not notice such deviation or may not realize its ramifications. Therefore, if such letters are not submitted to the Consultants, the contractor shall hold the Consultants and his consultants harmless for any adverse consequences resulting from the deviations being implemented. This shall apply regardless of whether the Consultants has reviewed or approved shop drawings containing the deviation, and will be strictly enforced.
3. Approval of proposed deviations, if any, will be made at discretion of Consultants.
4. Any of the approved deviations shall be deemed acceptable to this Contractor with no change in contract sum, unless the Consultant also receives a written notice to the contrary.

H. Submittal Notations: Submittals will be returned from the Consultants marked as illustrated below:

1. REVIEWED: "Reviewed and found generally acceptable. Minor deviations may be noted. No further submittal required if notations are complied with."
2. REVIEWED, DEVIATIONS NOTED; REVISE AND RESUBMIT: "Submittal contains deviations which must be corrected and confirmed by a new submittal."
3. REJECTED: "Submittal is incorrect to such an extent that the material is unacceptable, or in incomplete to such an extent that a review cannot be made. Resubmit in accordance with requirements of the Contract Documents."

I. Responsibility:

1. Intent of Submittal review is to check for capacity, rating, and certain construction features. Contractor shall ensure that the work meets the requirements of Contract Documents regarding information that pertains to fabrication processes or means, methods, techniques, sequences and procedures of construction; and for coordination of work of this or other Sections. Work shall comply with submittals marked "REVIEWED" to the extent they agree with the Contract Documents. Submittal review shall not diminish responsibility under this Contract for dimensional coordination, quantities, installation, wiring, supports and access for service, nor shop drawing errors or deviations from requirements of Contract Documents. The Consultant's noting of some errors while overlooking the others will not excuse the contractor from proceeding in error. Contract Documents are not limited, waived nor superseded in any way by review.
2. INFORM SUBCONTRACTORS, MANUFACTURERS, SUPPLIERS, ETC. OF SCOPE AND LIMITED NATURE OF REVIEW PROCESS AND ENFOREC COMPLIANCE WITH CONTRACT DOCUMENTS.

J. Schedule: Incorporate shop drawing review period into construction schedule so that Work is not delayed. Contractor shall assume full responsibility for delays caused by not incorporating the following review time requirements into his project schedule. Working days listed reference the time in Engineer's office. It does not include transmittal time or review time of Contractor or the Consultant. Allow at least 10 working days, exclusive of transmittal time, for review each time shop drawing is submitted or resubmitted with the exception that 20 working days, exclusive of transmittal time, are required for the following:

1. Coordination Drawings.
2. If more than five shop drawings of a single trade are received in one calendar week.

1.17 List of Proposed Equipment and Materials:

A. Within four weeks of Award of Contract and before ordering materials or equipment, submit complete list of materials and equipment and indicate manufacturer's name, addresses and telephone numbers. No consideration will be given to partial lists submitted out of sequence.

B. If the List of Materials and Equipment is not received within the prescribed time limit, provide the first-named manufacturer for all material and equipment on this project.

1.18 EQUIPMENT SUPPLIER'S INSPECTION

A. The following equipment shall not be placed in operation until a competent installation and service representative of the manufacturer has inspected the installation and certified that the equipment is properly installed, adjusted and lubricated; that preliminary operating instructions have been given; and that the equipment is ready for operation:

1. Pressure Boosting Pumps
2. Carbon-Dioxide Fire-Extinguishing Systems
3. Clean-Agent Fire-Extinguishing Systems
4. Wet-Chemical Fire-Extinguishing Systems
5. Dry-Chemical Fire-Extinguishing Systems
6. Fire Seal Systems
7. Seismic Restraints and Equipment Bracing

B. Contractor shall arrange for and obtain supplier's on-site inspection(s) at proper time(s) to assure each phase of equipment installation and/or connection is in accordance with the manufacturer's instructions.

C. Submit copies of start-up reports to the Engineer and include copies IN THE Project Close-Out and Owner's Operation and Maintenance Manuals.

D. Refer to each Section for specific equipment inspection requirements and procedure.

1.19 COORDINATION DRAWINGS:

A. A single set of coordination drawings shall be mutually prepared by all mechanical and electrical trades.

B. The initiation of these drawings begins with Sheet Metal Subcontractor.

C. The Sheet Metal Subcontractor shall prepare a complete set of electronic background drawings at scale not less than 3/8" equals 1'-0", showing structure and other information as needed for coordination. He shall show sheet metal layout thereon. These will be Coordination Drawings.

D. Each of the mechanical, electrical, plumbing fire protection and other specialty trade shall add its work to these background drawings with appropriate elevations and grid dimensions. Specialty trade information is require for fan rooms and mechanical rooms, horizontal exits from duct shafts, crossovers, and for spaces in and above ceilings where congestion of work may occur such as corridors, and even entire floors. Drawings shall indicate horizontal and vertical dimensions, to avoid interference with structural framing, ceilings, partitions, and other services.

E. Each specialty trade shall sign and date each coordination drawing. Return drawing to the Sheet Metal Subcontractor, who shall route them sequentially to all specialty trades.

F. Where conflicts occur with placement of materials of various trades, the Sheet Metal Subcontractor will be responsible to coordinate the available space to accommodate all trades. Any resulting adjustments shall be initialled and dated by specialty trade. The Sheet Metal Subcontractor shall then final date and sign each drawing. If he cannot resolve conflicts, the decision of the General Contractor/Construction Manager shall be final.

G. A Subcontractor who fails to promptly review and incorporate his work on the drawings shall assume full responsibility of any installation conflicts affecting his work and of any schedule ramifications.

H. Sheet Metal Subcontractor shall make prints of all coordination drawings. Fabrication shall not start until such transparencies of completed coordination drawings are received by the Consultant/Engineer and have been reviewed and approved.

I. The review of coordination drawings shall not diminish responsibility under this Contract for final coordination of installation and maintenance clearances of all systems and equipment with the other trades, structural and other work.

J. After review:

1. After review of coordination drawings, the method used to resolve interferences not previously identified shall be as in "MODIFICATIONS IN LAYOUT" above.
2. All changes to reviewed coordination drawings shall be in writing by the Consultants/Engineer prior to start of work in affected area.

K. Distribution of Coordination Drawings:

1. The Sheet Metal Subcontractor shall provide the following distribution of documents:

    a. One sepia (reproducible) of each Coordination Drawing to each specialty trade and affected Contractor for their use.
    b. One reproducible of each Coordination drawing to Owner.
    c. One sepia (reproducible) of each coordination drawing to the General Contractor/Construction Manager.
    d. The above documents can be submitted as electronic media upon agreement of all parties.

L. ALL FIREWALLS AND SMOKE PARTITIONS SHALL BE HIGHLIGHTED ON COORDINATION DRAWINGS FOR APPROPRIATE COORDINATION.

M. The main paths of egress and for equipment removal from main mechanical and electrical rooms must be clearly shown on coordination drawings.

N. Coordination Drawings shall include, but not limited to:

1. Fire protection and sprinkler system, piping and heads.
2. Plumbing systems, piping and equipment.
3. HVAC piping, systems and equipment.
4. Control systems.
5. Electrical distribution, systems and equipment.
6. Lighting systems and fixtures.
7. Sheet metal work, components and accessories, costs and boxes in terminals, etc.
8. Structural.
9. Electrical Equipment Room layouts.
10. Environmental Rooms and associated refrigeration/heating systems.
11. Partition/room layout.
12. Ceiling tile and grid.
13. Access panels.
14. Smoke and fire dampers.
15. Roof drain piping.
16. Major electrical conduit runs, panel-boards, feeder conduit and racks of branch conduit.
17. Above ceiling miscellaneous metal.
18. Heat tracing of piping.
19. Minimum access space requirements for all equipment for both installation and maintenance.

1.20 COORDINATION BUILDING INFORMATION MODEL (BIM)

A. General Requirements:

1. The General Contractor shall appoint a BIM Coordination Manager to prepare a BIM Execution Plan developed specifically for the project, and based on the Computer Integrated Construction (CIC) Research Program's BIM Planning procedures. The BIM Execution Plan will establish the protocols, expected levels of development, and authorized uses of Building Information Models on this Project and assigns specific responsibility for the development of each Model Element to a defined Level.

B. Services to be modelled:

1. All piping (above ½") and all equipment shall be modelled based on the proposed submitted products. The model may be used for production of shop drawings.

C. Clash Detection:

1. Perform three-dimensional component conflict analysis as part of coordination process with all other trades, including but not limited for Mechanical, Plumbing, Fire Protection and Fire Alarm. Resolve component conflicts prior to submittal of shop drawings. Indicate where conflict resolution requires modification of design requirements by Construction Manager.

D. 3D Assets:

1. The contractor shall hand over all digital data files related to the BIM execution plan at the end of the construction process, including all, but not limited to the shop drawings and as built conditions.

1.21 REGULATIONS, CODES, PERMITS, AND FEES

A. Conform to all rules, regulations, standards, ordinances and laws of local, state, and Federal governments and other authorities that have legal jurisdiction over the site.

B. Prior to commencement of work, notify State and applicable authorities as required and submit all of the applicable notifications for construction, operation and demolition. Secure required permits and inspections from any of the authorities having jurisdiction, for this work and pay for all fees required for permits, inspections and review, including special agency construction.

C. Include all utility and local building department charges for providing temporary and permanent electric services to buildings.

D. Provide Owner, Owner's Representative and Inspectors from any of the authorities / agencies having jurisdiction access to work at all times.

E. Contractor shall be responsible for all law violations caused by the work under this Division. Notify Construction Manager in writing when a discrepancy occurs between code requirements and work shown on drawings and resolve matter before proceeding with work.

F. When requirements cited in this specification conflict with each other or with Contract Documents, most stringent shall govern work. Consultants may relax this requirement when such relaxation does not violate ruling of authorities that have jurisdiction. Approval for such relaxation shall be obtained in writing.

G. Make corrections in the work as required by the Owner's Representative or Inspector to pass local regulations.

H. Contractor shall deliver to the Construction Manager any and all certificates of inspections, permits, and approvals. Contractor shall submit final inspection certificates signed by governing authorities to the Owner.

I. Make all necessary submissions to the State Fire Marshal, Local Fire Marshal, and other agencies having jurisdiction. Pay all required fees for review, registration and sign off.

1.22 OPERATING AND MAINTENANCE MANUALS

A. Obtain at time of purchase of equipment, three copies of operation and maintenance manuals for all items. Assemble literature in coordinated "D" ring notebooks. All information shall also be provided in electronic PDF format. Divide the manuals into three sections or books as follows:

B. System General Description and Information. Section shall include a general description of the systems used and contain names and addresses of manufacturers and local representatives who stock or furnish or repair parts for items or equipment. List of all major equipment as installed and include model number, capacities, nameplate data and manufacturer's location and purchase order information. Include in the manuals, parts catalogs for each item of equipment furnished with the components identified by number for replacement ordering. This section shall also include:

1. Letters from manufacturers certifying their supervision of equipment installation and startup procedures as required.
2. Factory certification test certificates.
3. Equipment test certificates.

C. Operation, Start-up and Shutdown Procedures. Section shall include directions for and sequence of operation for each item of the Fire Protection, Plumbing, Mechanical and Electrical systems.

D. Provide a step-by-step write-up and video of the operation, start-up and shut down procedures for all major equipment.

E. Problems, Solutions and Troubleshooting. Section shall include detailed procedures to be followed in case of equipment or system malfunctions. Include manufacturer's printed troubleshooting procedures into the operating manual for reference.

F. Preventative Maintenance. Section shall include preventative maintenance requirements and schedule for each piece of equipment.

G. Furnish three copies of manuals to the Consultant for approval and distribution to Owner. Deliver manuals no less than 30 days prior to project close-out or 10 days prior to commissioning whichever is sooner.

1.23 RECORD DOCUMENTS (AS-BUILTS)

A. As work progresses and for duration of Contract, maintain current complete and separate sets of prints of Contract drawings at job site. Record work completed and all changes from original Contract Drawings clearly and accurately including work installed as a modification or addition to original design. Include actual location of existing utilities if they differ from design documents.

B. Underground utility services, both inside and outside of buildings, shall be dimensioned from permanent structures or benchmark. Utility services outside of buildings shall also show depth of burial with reference to the finished ground floor elevation.

C. Drawings shall show record condition of details, sections, riser diagrams, control changes and correction to schedules. Schedules shall show actual manufacturer and make and model numbers of final equipment installation. All elements shall be dimensioned from grid lines or benchmarks and all elevations shall be noted. Construction notes (such as component numbers, conflict notes, etc.) shall be removed and the drawings shall clearly be noted in the title block as being as-built drawings.

D. At the completion of the project, prepare a complete set of record drawings, showing all systems actually installed, as well as electronic files on latest CAD version.

E. The design tracings will be made available for Contractor's copying, at his expense, into reproducible to serve as background drawings. The quantity of design tracings, which are made available shall in no way be interpreted as setting a limit to the number of drawings necessary to show required information. Contractor's professional draftsperson shall transfer changes to record files and then submit the electronic files and three sets of prints to the Consultant for comments as to compliance with this section.

F. The record set reproducible, as corrected and recorded by the Contractor, shall be submitted to the Owner's Representative for approval prior to authorization for final payment. Record drawings shall be certified as to their correctness by the signature of the Contractor, and shall be stamped or otherwise identified as record drawings. THE CONSULTANT WILL NOT CERTIFY THE ACCURACY OF THE RECORD DRAWINGS - THIS IS THE SOLE RESPONSIBILITY OF THE CONTRACTOR.

G. Each trade shall submit a record set for approval by the building department in a form acceptable to the department, when required by the jurisdiction. Such drawing format size changes, and supplemental information required for the submittal are the requirement of the contractor.

1.24 COOPERATION BETWEEN TRADES

A. Cooperate with all other Divisions performing work on this project as necessary to achieve a complete neatly fitted installation for each condition. Consult the Drawings and Specifications to determine nature and extent of work specified in other Divisions that adjoins or attaches to the work of this Division. Confer with other Divisions at the site to coordinate this work with theirs in view of job conditions to the end that interferences may be eliminated and that maximum head room and clearance may be obtained. In the event that interferences develop, the Owner's Representative's decision will be final as to which Division shall relocate its work, and no additional compensation will be allowed for the moving of piping, ductwork, conduit, or equipment, to clear such interferences. Provide templates, information, and instructions to other divisions to properly locate holes and openings to be cut or provided

1.25 HOIST, RIGGING, TRANSPORTATION AND SCAFFOLDING

A. Provide all scaffolding, staging, cribbing, tackle hoist and rigging necessary for placing all materials and equipment in their proper places in the Project. All temporary work shall be removed from the premises when its use is no longer required.

1.26 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment in its original package to prevent damage or entrance of foreign matter. Perform all handling and shipping in accordance with manufacturer's recommendations. Provide protective coverings during construction.

B. Identify materials and equipment delivered to Site to permit check against approved materials list, reviewed Shop Drawings.

C. Keep all materials clean, dry and free from damaging environments during construction.

D. Cap all openings in piping daily to protect against entry by foreign matter.

E. Protect premises and Work of other Divisions from damage arising out of installation of Work of this Division.

F. Perform Work in manner precluding unnecessary safety and hazard.

G. Protect from loss or damage. Replace lost or damaged materials and equipment with new at no increase in Contract Sum. Protect from damage, water, dust, etc., material, equipment and apparatus provided under this Division, both in storage and installed, until Notice of Completion has been filed. Provide temporary storage facilities for material and equipment. Material, equipment or apparatus damaged because of improper storage or protection will be rejected. Remove from Site and provide new, duplicate material, equipment or apparatus in replacement of that rejected.

H. All stock piled piping shall be placed on dunnage, and protected from weather and from entry of foreign material. All stored materials and equipment shall be carefully inspected prior to installation and replaced with new material or equipment if found to be damaged, corroded, etc.

1.27 GUARANTEE AND 24 HOUR SERVICE

A. Guarantee the Work of this section for one year following the date of Substantial Completion or successful system performance whichever requires later. The warranty may also commence if a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization of the Owner. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the owner.

B. The guarantee shall repair or replace defective materials, equipment, workmanship and installation that develop within this period, promptly and to the Consultant's satisfaction and correct damage caused in making necessary repairs and replacements under guarantee within Contract Price.

C. In addition to guarantee requirements of Division 1 and of Paragraph A above, obtain written equipment and material warranties offered in manufacturer's published data without exclusion or limitation, in Owner's name.

D. Replace material and equipment that require excessive service during guarantee period as defined and as directed by the Consultant.

E. Provide 24 hour service beginning on the date of substantial completion and lasting until the termination of guarantee period. Service shall be at no cost to Owner. Service can be provided by this Contractor or a separate service organization. Choice of service organization shall be subject to the Consultant and Owner approval. Submit name and phone number that will be answered on a 24 hour basis each day of the week, for the duration of the service.

F. Submit copies of equipment and material warranties to Consultants before final payment.

G. At end of guarantee period, transfer manufacturer's equipment and warranties still in force to Owner.

H. This paragraph shall not be interpreted to limit Owner's rights under applicable codes and laws under this Contract.

I. Part 2 Paragraphs of the Specification sections may specify warranty requirements that may exceed those of this Paragraph.

J. Use of systems provided under this Section for temporary services and facilities shall not constitute Final Acceptance of work nor beneficial use by Owner, and shall not institute guarantee period.

K. Provide manufacturer's engineering and technical staff at site to analyze and rectify problems that develop during guarantee period immediately. If problems cannot be rectified immediately to Owner's satisfaction, advise the Consultant in writing, describe efforts to rectify situation, and provide analysis of cause of problem. Consultants will suggest course of action.

PART 2 PRODUCTS

2.1 GENERAL

A. Equipment and materials shall be as described in the respective Sections of Division 21, 22, 23 and Division 26 and as shown.

2.2 MATERIALS

A. Equipment specified by manufacturer's number shall include all accessories, controls, etc., listed in catalog as standard with equipment. Furnish optional or additional accessories as specified. And or/as required to provide a fully operational installation.

B. Equipment, material damaged during transportation, installation, and operation is considered as totally damaged. Replace with new. Payment for this equipment shall not be approved. Variance from this permitted only with written acceptance.

C. All items of materials in each category of equipment shall be of one manufacturer.

D. Material and Equipment-General Requirements:

1. All equipment and components shall be New.
2. Testing agency labeled or with other identification wherever standards have been established.
3. Owner's Representative reserves right to reject items not in accordance with Specification either before or after installation.
4. Comprised to render complete and operable systems; provide additional items needed to complete installation to realized design.
5. Compatible with space allocated. Modifications necessary to adjust items to space limitations at Contractor's expense.
6. Installed fully operating and without objectionable noise or vibration.

PART 3 EXECUTION

3.1 COMMISSIONING OF EQUIPMENT AND SYSTEMS

A. General

1. Completion of startup and commissioning shall be accomplished as a prerequisite for substantial completion and shall be completed for each phase of construction.
2. Operate and maintain systems and equipment until final acceptance by Owner.
3. All guarantees and warranties shall not begin until final acceptance of the systems and equipment by the Owner. Acceptance requires, at a minimum complete systems and commissioning.
4. The Owner maintains the right to have access to the entire project site to develop his own operational procedures.

B. Comprehensive Work Plan and Reporting

1. Provide detailed, methodical, scheduled, start up and commissioning procedures and execution of same and every system and piece of equipment provided.
2. Attend start up and commissioning meetings on a regular basis, as directed by the General Contractor or Construction Manager.
3. Develop and provide a written work plan with detailed procedures for this work and submit, using shop drawing submittal procedure, within 6 weeks of the contract award. The work plan shall include provisions for an integrated start up plan and schedule. The plan and schedule shall identify tasks, start and completion dates, critical path items, interface requirements with other trades and major equipment start up, as minimum requirements of the plan. The plan and schedule shall clearly identify work in each construction phase, as well.
4. The purpose of this work plan is to provide for smooth, quick, and efficient start up and commissioning of systems and equipment and for a smooth transition to turn the complete, correctly operating building over to the Owner, at each phase of construction.
5. The Owner and the Consultant will have input to and be part of approval process for startup and commissioning plan.
6. Develop and submit for approval a specific start up, check out and sign off form for every piece of major equipment.
7. Develop and submit for approval a specific start up, check out and sign off form for every piece of major system.
8. Systems shall be operated under actual or simulated full load conditions. Identify the operating conditions in the work plan.
9. Work plan shall incorporate the below specified "Demonstration of Successful Operation"
10. The Consultant/Owner may check the completed and commissioned installation either sequentially as different parts are completed, and/or when the entire installation is complete, at sole option of the Consultant/Owner.
11. Each contractor shall arrange that an officer of his contracting company shall certify that each and every system has been tested. At the conclusion of the tests, this contractor shall submit a letter and enclosed commissioning forms signed by the officer stating:

    a. That he/she is the officer of the company.
    b. That he/she certifies that the specified testing of the systems has been performed by the company (give the name and dates of system testing).
    c. The results of testing as compared to specified performance, listing the name, title, and company affiliation of all those witnessing and performing these tests.

C. Commissioning

1. Commission equipment and systems in accordance with the approved work plan, completing the startup, check out and sign off forms for each piece of equipment and each system.

2. Provide qualified personnel, equipment, apparatus and services for startup and testing of equipment and systems, to obtain the performance shown in schedules, as specified or on commissioning forms, and as required by codes, standards, regulations and authorities having jurisdiction including Municipal Inspectors, Owners and Consultants.
3. Start up and testing procedures as may be outlined in various mechanical and electrical sections of the specifications are the minimum effort required for the project. Contractor shall use any additional procedures he feels will be necessary to properly start up and test the systems and equipment actually installed on the job at no additional cost to the Owner.
4. Provide capacity and performance of equipment by field testing. Install thermowells and gauge connections and, at no additional cost to Owner, equipment and instruments required for testing.
5. Qualified representative of equipment manufacturer shall be present at test.
6. For each piece of equipment, copy nameplate data and include with the letter and start up, check out and sign off forms referred to above.
7. Do not cover or conceal work before testing and inspection and obtaining approval.
8. Leaks, damage and defects discovered or resulting from startup and testing shall be repaired or replaced by this contract to like-new condition with acceptable materials. Tests shall be continued until system operates without adjustments or repairs.

D. Demonstration of Successful Operation: After all components and every system have been completely commissioned provide certification from the code authority having jurisdiction the system is approved for its intended use. This shall be successfully concluded before systems are accepted by the Owner.

3.2 SPECIAL RESPONSIBILITIES:

A. Cooperate and coordinate with work of other Sections in executing work of this Section.

1. Perform work such that progress of entire project including work of other Sections shall not be interfered with or delayed.
2. Provide information as requested on items furnished under this Section which shall be installed under other Sections.
3. Obtain detailed installation information from manufacturers of equipment provided under this section.
4. Obtain final roughing dimensions or other information needed for complete installation of items furnished under other Sections or by Owner.
5. Keep fully informed as to shape, size and position of openings required for material or equipment to be provided under this and other Sections. Give full information so that openings required by work of this Section may be coordinated with other work and other openings and may be provided for in advance. In case of failure to provide sufficient information on proper time, provide cutting and patching or have same done, at own expense and to full satisfaction of Consultants.
6. Provide information as requested as to sizes, number and locations of pads necessary for floor mounted equipment provided under this Section.
7. Notify Consultants of location and extent of existing piping, conduit, ductwork and equipment that interferes with new construction. In coordination with and with approval of Consultants, relocate piping, ductwork and equipment to permit new work to be provided as required by Contract Documents. Remove non-functioning and abandoned piping, ductwork and equipment as directed by Consultants. Dispose of or store items as requested by Consultants.

B. Installation Only Items

1. Where this contractor is required to install items which it does not purchase, it shall coordinate delivery and be responsible for their unloading from delivery vehicles and for their safe handling and field storage up to time of installation. This trade shall be responsible for:

    a. Any necessary field assembly and internal connections, as well as mounting in place of the items, including the purchase and installation of all dunnage supporting members and fastenings necessary to adapt to Consultant's and structural conditions.
    b. Their connection to building systems including the purchase and installation of all terminating fittings necessary to adapt and connect them to the building systems.

2. This contractor shall carefully examine such items upon delivery. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of work of this contractor will be considered only if presented in writing within one week of their date of delivery. Unless such claims have been submitted this contractor shall be fully responsible for the complete reconditioning or replacement of the damaged items.

C. Maintenance of equipment and systems: Maintain equipment and systems until Final Acceptance. Ensure adequate protection of equipment and material during delivery, storage, installation and shutdown and during delays pending final test of systems and equipment because of seasonal conditions.

D. Use of premises: Use of premises shall be restricted as directed by the Consultant and as required below:

1. Remove and dispose of dirt and debris, and keep premises clean. During progress of work, remove equipment and unused material. Put building and premises in neat and clean condition, and do cleaning and washing required to provide acceptable appearance and operation of equipment, to satisfaction of the Consultant.
2. Store materials in a manner that will maintain an orderly clean appearance. If stored on-site in open or unprotected areas, all equipment and material shall be kept off the ground by means of pallets of racks and covered with tarpaulins.
3. Do not interfere with function of existing sewers and water and gas mains, electrical or mechanical systems and services. Extreme care shall be observed to prevent debris from entering pipe, ductwork and equipment. Confer with the Consultant as to the disruption of services or other utilities due to testing, connection of new work to existing. Interruption of services shall be performed at time of day or night deemed by Owner to provide minimal interference with normal operation. Obtain Owner's approval of the method proposed for minimizing service interruption.

E. Surveys and Measurements:

1. Base measurements, both horizontal and vertical, on reference points established by Contractor and be responsible for correct laying out of work.
2. In event of discrepancy between actual measurements and those indicated, notify the Consultant in writing and do not proceed with work until written instructions have been issued by the Consultant.

F. Fireproofing:

1. Clip, hangers, clamps, supports and other attachments to surfaces to be fireproofed shall be installed, insofar as possible prior to start of spray fiber work.

2. Conduit and other items which would interfere with proper application of fireproofing shall be installed after completion of spray fiber work.
3. Patching and repairing of fireproofing due to cutting or damaging to fireproofing during course of work specified under this section shall be shall be performed by installer of fireproofing and paid for by the trade responsible for damage and shall not constitute grounds for an extra to Owner.

G. Temporary Utilities:

1. Refer to Division 1 regarding requirements.
2. Furnish temporary equipment, and piping as needed during the construction phase. Remove temporary items after use.

3.3 MATERIAL AND WORKMANSHIP

A. Work shall be neat and rectilinear. Conduit shall run concealed except in mechanical rooms and areas where no hung ceiling exists. Install material and equipment to comply with manufacturers. Recommended Requirements. Rough Work will be rejected. Work shall be properly and effectively protected, and conduit openings shall be temporarily closed to prevent obstruction and damage before completion.

B. Except as specified otherwise, material and equipment shall be new. Provide supplies, appliances and connections necessary for complete and operational installation. Provide components required or recommended by OSHA and applicable NFPA documents.

C. Finish of materials, components and equipment shall be as approved by the Consultant and shall be resistant to corrosion and weather as necessary.

D. Owner will not be responsible for material and equipment before testing, commissioning, and acceptance.

3.4 CONTINUITY OF SERVICES

A. Do not interrupt existing services without Owner's approval.

B. Schedule interruptions in advance, according to Owner's instructions. Submit, in writing, with request for interruption, methods proposed to minimize length of interruption.

C. Interruptions shall be scheduled at such times of day and work so that they have minimal impact to Owner's operations.

D. Subcontractor shall coordinate any shutdowns of existing systems as follows:

1. Give proper notice to Owner when making shutdowns; a minimum of fourteen full days are required.
2. Minimize shutdowns of any system.
3. Provide temporary services where required and perform shutdown and tie-ins at a time convenient to Owner.
4. Subcontractor shall be responsible for completing and filing Owner's shutdown notice questionnaire.
5. Perform required survey and inspection work required by the notice for shutdown.

E. Include premium time work associated with interruption of services and/or shutdown as necessary to avoid disruption to Owner's operations.

3.5 ANCHORS AND INSERTS:

A. Inserts shall be iron or steel of type to receive machine bolt head or nut after installation. Insert shall permit adjustment of bolt in one horizontal direction and shall develop strength of bolt when installed in properly cured concrete.

B. Provide anchors as necessary for attachment of equipment support and hangers.

3.6 CORE DRILLING

A. Core drilling is to be avoided.

B. Set sleeves prior to installation of structure for passage of conduits, etc.

C. Where core drilling is unavoidable, or required by renovation projects, locate all required openings prior to coring and submit to the Consultant for review.

D. Coordinate openings with General Contractor/Construction Manager and all other trades.

E. Core drilling is to be provided by the Contractor for General Construction and not by the M/E subcontractors.

F. Do not disturb existing systems.

G. Thoroughly investigate existing conditions in vicinity of required opening prior to coring.

3.7 CUTTING AND PATCHING:

A. Complete cutting and patching in accordance with Division 1, Cutting and Patching Article, and as follows.

B. Provide all sleeves, core drilling, carpentry, cutting and patching required for proper installation of material and equipment specified in this Division.

C. Do not cut or drill structural members without written approval of Owner's Representative and structural engineer.

D. No cutting or patching should be done without first receiving the Consultant's and Structural Engineer's written approval.

E. Any damage caused by cutting and patching shall be restored to the original condition as required by the Consultant.

3.8 VIBRATION CONTROL:

A. Coordinate with Division 1.

B. Design criteria for all the Work of Division 21 shall be as specified in 210548.

3.9 WATERPROOF CONSTRUCTION:

A. Maintain waterproof integrity of penetrations of materials intended to be waterproof. Provide flashing at exterior wall and roof penetrations. Caulk watertight penetrations of foundation walls and floors. Provide membrane clamps at penetrations of waterproof membranes.

B. Provide galvanized sheet metal weather protection canopies, hoods or enclosures over all out-of-doors equipment, the operation or maintenance of which would be impaired by rainwater. This requirement applies to damper operators and bearing, damper motors, controls, and instruments. See other paragraphs in this Division for application of this requirement to panels, motors, and devices.

3.10 RESTORATION OF DAMAGE:

A. Repair or replace, as directed by the Consultant and/or Owner's Representative, materials and parts of premises which become damaged as result of installation of Work of this Division. Remove replaced parts from premises.

3.11 ROOF OPENINGS AND CURBS

A. Roof openings where required shall be coordinated with the other affected trades and all flashing and patching shall be as per details indicated on the Consultant's plans.

3.12 TOOLS AND EQUIPMENT

A. Furnish all tools and equipment necessary for the proper installation, protection and upkeep of the Work.

3.13 ADJUSTMENTS

A. Preliminary Operation:

1. Operate any portion of installation for Owner's convenience if so requested by Construction Manager. Such operation does not constitute acceptance of Work as complete. Cost of utilities, such as gas and electrical power, will be borne by Owner if Owner requests operation.

B. Start-up Service:

1. Prior to startup, ensure that systems are ready for their intended use.

C. Start and operate all systems. Provide services of factory trained technicians for start up of major equipment and systems.

D. Adjusting:

1. Adjust all equipment and system components as shown or as otherwise required to result in intended system operation.
2. Thereafter, as a result of system operation or as directed by Owner's Representative, make readjustments as necessary to refine performance and to effect complete system "tune-up".
3. After completion of testing and adjustment, operate the different systems and equipment under normal working conditions for 72 hours continuously and show specified performance.
4. If, in the opinion of the Consultant, performance of equipment or systems is not in accordance with specifications or submitted data, alter or replace equipment at no increase in Contract Sum. The Contractor, at his option, may order tests from an independent approved laboratory to prove compliance. All such tests shall be at no increase in Contract Sum. Repeat process as often as required. If the reason for unsatisfactory operation is design errors all additional cost for corrective measures will be reimbursed to the contractor.
5. At completion of Work, provide written certification that all systems are functioning properly without defects.

E. Noise:

1. Cooperate in reducing any objectionable noise or vibration caused by electrical systems to the extent of adjustments to specified and installed equipment and appurtenances.
2. Cooperate in adjustment of mechanical systems and terminal devices, as directed by Owner's Representative, to obtain specified acoustic properties.
3. Completely correct noise problems caused by failure to make installation in accordance with Contract Documents, including labor and materials required as a result of such failure, at no increase in Contract Sum. Includes refinish walls, floors etc.

3.14 INSTALLATION OF EQUIPMENT

A. Use printed descriptions, specifications and recommendations of manufacturers as a guide for installation of Work.

B. Assemble equipment required to be field assembled under the direct supervision of the manufacturers' agent. Prior to the final acceptance submit letters from the manufacturers that this has been done.

C. Avoid interference with structure and with work of other trades, preserving adequate headroom and clearing doors and passageways, to the satisfaction of the Consultant and in accordance with code requirements. Installation shall permit clearance for access to equipment for repair, servicing and replacement.

D. Install equipment so as to properly distribute equipment loads on building structural members provided for equipment support under other Sections. Roof mounted equipment shall be installed and supported on structural steel provided under other Sections.

E. Provide suspended platforms, strap hangers, brackets, shelves, stands or legs as necessary for floor, wall of ceiling mounting of equipment as required.

F. Provide steel supports and hardware for proper installation of hangers, anchors, guides, etc.

G. Provide cuts, weights, and other pertinent data required for proper coordination of equipment support provisions and installations.

H. Structural steel and hardware shall conform to Standard specifications of ASTM; use of steel and hardware shall conform to requirements of Section V of Code of Practice of American Institute of Steel Construction.

I. Verify site conditions and dimensions of equipment to ensure access for proper installation of equipment without disassembly, which will void warrantee. Report in writing to the Consultant, prior to purchase or shipment of equipment involved, on conditions which may prevent proper installation.

3.15 PAINTING

A. Equipment installed shall have shop coat of non-lead paint. Hangers and supports shall have one coat of non-lead primer. Finish painting, including painting of various conduit or wire way systems, shall be done under other Sections.

B. Paint all outside exposed equipment and equipment supports with two coats of weather resistant enamel.

C. Properly prepare Work under this Division to be finish painted under Division 9.

D. Refer to standard paint colors for all Fire Protection equipment inside the Building.

3.16 SELECTIVE DEMOLITION

A. Refer to all drawings for general description of areas requiring demolition.

B. Refer to General Contractor's/Construction Manager's Instructions for all existing equipment and materials that shall remain the property of the Owner.

C. Items of value which are not directed to be returned to the Owner shall become the property of the Contractor. Storage or sale of items on the project site is prohibited.

D. Protection: Ensure the safe passage of persons in and around building during demolition. Prevent injury to persons and damage to property. Provide adequate shoring and bracing to prevent collapse. Immediately repair damaged property to the condition before being damaged. Take effective measures to prevent windblown dust.

E. Utilities: Maintain all utilities except those requiring removal or relocation. Keep utilities in service and protect from damage. Do not interrupt utilities serving used areas without first obtaining permission from the utility company and the Owner. Provide temporary services as required.

3.17 JOBSITE SAFETY

A. Neither the professional activities of the Engineer, nor the presence of the Engineer or his or her employees and sub-consultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Engineer and his or her personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Engineer and the Engineer's consultants shall be indemnified and shall be made additional insured's under the Contractor's general liability insurance policy.

3.18 FINAL JOBSITE OBSERVATION

A. As the work nears completion, the Contractor is to review the requirements of the Contract Documents, inspect the work and inform all parties involved of the work to be corrected or completed before the project can be deemed substantially complete.

B. When the Project is substantially complete, In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation. Notify the Owner's Representative in writing of this fact, listing any items of Work remaining incomplete, the reason therefore, and the anticipated date that all remaining work will be completed. The Contractor shall inform the certification that the project is complete and ready for a final punch; the Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.

C. It is understood that if the Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Engineers additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

D. The Contractor shall carry out their own final inspection and satisfy the Work.

E. The Owner's Representative reserves the right to cancel and reschedule the inspection in the event considerable more work remains to be completed or corrected than indicated in the written request for inspection.

F. All items not completed or found not complying with drawings or specifications by the Owner's Representative will be identified in their inspection report.

G. Correct all items on inspection report. Make the correction and initial and date each item on the report after corrections have been completed.

H. Include the fee for all local inspections.

3.19 INSTRUCTING THE OWNER'S REPRESENTATIVES

A. Adequately instruct the Owner's designated representatives in the maintenance, care,and operation of all systems installed under this contract.

B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.

C. The Owner has the option to video tape all instructions. Coordinate schedule of instructions to facilitate this recording.

D. The instructions shall include:

1. Maintenance of equipment.
2. Start-up procedures for all major equipment.
3. Description of fire protection system operation.

3.20 PROJECT CLOSE-OUT PROCEDURE

A. General

1. The requirements of this section are in addition to and supplement the requirements outlined in Division 1.
2. It shall be each contractor's responsibility to personally hand-deliver all of the required project close-out checklist items and to obtain Owner's authorized representative(s) signed receipt on all items requiring Owner sign-off.

B. Project Close-Out Checklist

1. Review requirements of each section of the specifications and submit for approval to Consultants the sign-off forms which shall become the project close-out checklist. These, at a minimum, shall include the following information shown in attached Project Closeout Checklist Example. The Consultants and/or Owner may incorporate additional specific items to the following checklist which shall become part of project requirements.
2. Close-Out Checklist Example:

PROJECT CLOSE-OUT			
PROJECT:			
DIVISION NO:			
CONTRACTOR:			
ITEM1	DATES		OWNER'S SIGN-OFF
	COMPLETED	RECEIVED BY OWNER	
Permits			
City and County Inspection			
Manufacturer's Warranties			
State Fire Rating Data			
Copy of Final Shop Drawings			
List and Possession of Spare Parts			
Pressure Tests			
Equipment Tests Required by Specs			
O&M Manuals			
Record Documents			

Coordination Drawings			
Commissioning Reports/Letters/Forms			
On Site Training Complete			
Protective Device Settings			
Valve Tags and Charts			
Insurance Underwriters Approvals			
Final Punch List (Initialed by contractor that items are complete)			
Building Certificate of Occupancy			
24 Hr. Phone No. for Service During Guarantee Period.			
1 Provide separate line item for each specified item (do not group items).			

READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

In order to prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

3. 1. Penetrations fire sealed and labeled in accordance with specifications.
4. 2. Fire Protection System Operational
5. 3. Pipes and Equipment Labeled
6. 4. Inspection report approved by code authority having jurisdiction
7. 5. Provide spare parts and additional materials as specified in the individual specification sections.

Accepted by:

Contractor _____

By _____ Date _____

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Engineer so that the final observation can be scheduled.

It is understood that if the Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

END OF SECTION 210000

SECTION 210513 - COMMON MOTOR REQUIREMENTS FOR FIRE SUPPRESSION EQUIPMENT

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 general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

C. Comply with IEEE 841 for severe-duty motors.

PART 3 EXECUTION (Not Applicable)

END OF SECTION 210513

SECTION 210517 - SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

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:

1. Sleeves.
2. Sleeve-seal systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 PRODUCTS

2.1 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

B. Description:

1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20 psig minimum.
3. Sealing Elements: [EPDM-rubber] [High-temperature-silicone] [Nitrile (Buna N)] interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
4. Pressure Plates: [Carbon steel] [Composite plastic] [Stainless steel] [Stainless steel, Type 316].
5. Connecting Bolts and Nuts: [Carbon steel, with corrosion-resistant coating, ASTM B 633] [Stainless steel] [Stainless steel, Type 316,] of length required to secure pressure plates to sealing elements.

PART 3 EXECUTION

3.1 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.

B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls below Grade:

a. Piping Smaller Than NPS 6: Cast-iron pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

2. Concrete Slabs-on-Grade:

a. Piping Smaller Than NPS 6: Cast-iron pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs above Grade:

a. Piping Smaller Than NPS 6: Steel pipe sleeves.

4. Interior Partitions:

a. Piping Smaller Than NPS 6: Steel pipe sleeves.

END OF SECTION 210517

SECTION 210518 - ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

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:

1. Escutcheons.
2. Floor plates.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Steel Type: With finish and setscrew fastener.

2.2 FLOOR PLATES

A. Split Floor Plates: Steel with concealed hinge.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

a. Chrome-Plated Piping: One-piece steel with polished, chrome-plated finish.
b. Insulated Piping: One-piece cast brass with finish.

c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece cast brass with finish.
d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece cast brass with finish.
e. Bare Piping in Equipment Rooms: One-piece cast brass with finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping : One-piece, floor plate.
2. Existing Piping: Split floor plate.

3.2 FIELD QUALITY CONTROL

A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION 210518

SECTION 210523 - GENERAL-DUTY VALVES FOR WATER-BASED FIRE-SUPPRESSION PIPING

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:

1. Two-piece ball valves with indicators.
2. Iron OS&Y gate valves.
3. Trim and drain valves.

1.3 DEFINITIONS

A. NRS: Nonrising stem.

B. OS&Y: Outside screw and yoke.

C. SBR: Styrene-butadiene rubber.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, and weld ends.
3. Set valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

D. Protect flanges and specialties from moisture and dirt.

PART 2 PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of valve from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. UL Listed: Valves shall be listed in UL's "Online Certifications Directory" under the headings listed below and shall bear UL mark:

1. Fire Main Equipment:

a. Indicator Posts, Gate Valve
b. Ball Valves, System Control
c. Butterfly Valves
d. Check Valves
e. Gate Valves

2. Sprinkler System & Water Spray System Devices

a. Valves, Trim and Drain

B. FM Global Approved: Valves shall be listed in its "Approval Guide," under the headings listed below:

1. Automated Sprinkler Systems:

a. Indicator posts.
b. Valves.

1) Gate valves.
2) Check valves
3) Miscellaneous valves.

C. ASME Compliance:

1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B31.9 for building services piping valves.

D. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

E. NFPA Compliance for valves:

1. Comply with NFPA 13, NFPA 14, NFPA 20, and NFPA 24.

F. Valve Pressure Ratings: Not less than the minimum pressure rating indicated or higher, as required by system pressures.

G. Valve Sizes: Same as upstream piping unless otherwise indicated.

H. Valve Actuator Types:

1. Worm-gear actuator with handwheel for quarter-turn valves, except for trim and drain valves.
2. Handwheel: For other than quarter-turn trim and drain valves.
3. Handlever: For quarter-turn trim and drain valves NPS 2 and smaller.

2.3 TWO-PIECE BALL VALVES WITH INDICATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. NIBCO INC.
2. Victaulic Company.

B. Description:

1. UL 1091, except with ball instead of disc and FM Global approved for indicating valves (butterfly or ball type), Class Number 1112.
2. Minimum Pressure Rating: 175 psig.
3. Body Design: Two piece.
4. Body Material: Forged brass or bronze.
5. Port Size: Full or standard.
6. Seats: PTFE.
7. Stem: Bronze or stainless steel.
8. Ball: Chrome-plated brass.
9. Actuator: Worm gear
10. Supervisory Switch: Internal or external.
11. End Connections for Valves NPS 1 through NPS 2: Threaded ends.
12. End Connections for Valves NPS 2-1/2: Grooved ends.

2.4 IRON OS&Y GATE VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Clow Valve Company; a subsidiary of McWane, Inc.
2. Hammond Valve.
3. Kennedy Valve Company; a division of McWane, Inc.
4. NIBCO INC.
5. Victaulic Company.
6. WATTS.

B. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig.
3. Body and Bonnet Material: Cast or ductile iron.

4. Wedge: Cast or ductile iron, or bronze[with elastomeric coating].
5. Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Flanged.

2.5 TRIM AND DRAIN VALVES

A. Ball Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Apollo Flow Controls; Conbraco Industries, Inc.
   b. FNW; Ferguson Enterprises, Inc.
   c. Metso Automation USA Inc.
   d. NIBCO INC.
   e. Red-White Valve Corp.
   f. Tyco by Johnson Controls Company.
   g. Victaulic Company.

2. Description:

   a. Pressure Rating: 250 psig.
   b. Body Design: Two piece.
   c. Body Material: Forged brass or bronze.
   d. Port size: Full or standard.
   e. Seats: PTFE.
   f. Stem: Bronze or stainless steel.
   g. Ball: Chrome-plated brass.
   h. Actuator: Handlever.
   i. End Connections for Valves NPS 1 through NPS 2-1/2: Threaded ends.
   j. End Connections for Valves NPS 1-1/4 and NPS 2-1/2: Grooved ends.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 INSTALLATION, GENERAL

A. Comply with requirements in the following Sections for specific valve-installation requirements and applications:

1. Section 211100 "Facility Fire-Suppression Water-Service Piping" for application of valves in fire-suppression water-service piping.
2. Section 211200 "Fire-Suppression Standpipes" for application of valves in fire-suppression standpipes.
3. Section 211313 "Wet-Pipe Sprinkler Systems" for application of valves in wet-pipe, fire-suppression sprinkler systems.
4. Section 211316 "Dry-Pipe Sprinkler Systems" for application of valves in dry-pipe, fire-suppression sprinkler systems.
5. Section 211339 "Foam-Water Systems" for application of valves in AFFF piping.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply, except from fire-department connections. Install permanent identification signs, indicating portion of system controlled by each valve.

C. Install double-check valve assembly in each fire-protection water-supply connection.

D. Install valves having threaded connections with unions at each piece of equipment arranged to allow easy access, service, maintenance, and equipment removal without system shutdown. Provide separate support where necessary.

E. Install valves in horizontal piping with stem at or above the pipe center.

F. Install valves in position to allow full stem movement.

G. Install valve tags. Comply with requirements in Section 210553 "Identification for Fire-Suppression Piping and Equipment" for valve tags and schedules and signs on surfaces concealing valves; and the NFPA standard applying to the piping system in which valves are installed. Install permanent identification signs indicating the portion of system controlled by each valve.

END OF SECTION 210523

SECTION 210533 - HEAT TRACING FOR FIRE-SUPPRESSION PIPING

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 heat tracing for fire-suppression piping with the following electric heating cables:

1. Self-regulating, parallel resistance.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

B. Shop Drawings: For electric heating cable.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Chromalox, Inc.
2. Raychem; Tyco Thermal Controls.

B. Comply with IEEE 515.1.

C. Electrical Insulating Jacket: Flame-retardant polyolefin.

D. Maximum Operating Temperature (Power On): 150 deg F.

E. Maximum Exposure Temperature (Power Off): 185 deg F.

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.

2.2 CONTROLS

A. Corrosion-resistant, waterproof control enclosure.

B. Provide with Bacnet BMS interface

2.3 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer or as recommended in writing by manufacturer.

B. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install electric heating cable where indicated and according to NFPA 70 and NFPA 13.

B. Install electric heating cable across expansion joints according to manufacturer's written instructions; use cable to allow movement without damage to cable.

C. Install electric heating cables after piping has been tested and before insulation is installed.

D. Install electric heating cables according to IEEE 515.1.

E. Install insulation over piping with electric cables according to Section 210700 "Fire-Suppression Systems Insulation."

F. Install warning tape on piping insulation where piping is equipped with electric heating cables.

G. Set field-adjustable switches and circuit-breaker trip ranges.

3.3 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Connect heat-tracing controls to fire-alarm system according to NFPA 13.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
2. Test cables for electrical continuity and insulation integrity before energizing.
3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

D. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

E. Cables will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.5 PROTECTION

A. Protect installed heating cables, including nonheating leads, from damage during construction.

B. Remove and replace damaged heat-tracing cables.

END OF SECTION 210533

SECTION 210553 - IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

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:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Valve tags.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Equipment-Label Schedule: Include a listing of all equipment to be labeled and the proposed content for each label.

C. Valve Schedules: Valve numbering scheme.

PART 2 PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032 inch thick, with predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Red.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
6. Fasteners: Stainless-steel rivets.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

C. Equipment-Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Red.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service and showing flow direction according to ASME A13.1.

B. Self-adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

C. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: Size letters according to ASME A13.1 for piping.

D. Pipe-Label Colors:

1. Background Color: Safety Red.
2. Letter Color: White.

2.4 VALVE TAGS

A. Description: Stamped or engraved with 1/4-inch letters for piping-system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032 inch thick, with predrilled holes for attachment hardware.
2. Fasteners: Brass beaded chain S-hook.
3. Valve-Tag Color: Safety Red.
4. Letter Color: White.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be installed.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. Piping: Painting of piping is specified in [Section 099123 "Interior Painting."] [Section 099600 "High-Performance Coatings."]

B. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection excluding short takeoffs. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit a view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of [50 feet] <Insert dimension> along each run. Reduce intervals to [25 feet] <Insert dimension> in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes including pipes where flow is allowed in both directions.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in fire-suppression piping systems. List tagged valves in a valve-tag schedule.

END OF SECTION 210553

SECTION 211313 - WET-PIPE SPRINKLER SYSTEMS

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:

1. Pipes, fittings, and specialties.
2. Sprinklers.
3. Alarm devices.
4. Pressure gauges.

1.3 DEFINITIONS

A. High-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure higher than standard 175 psig, but not higher than [250 psig] [300 psig].

B. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175-psig maximum.

1.4 FIELD CONDITIONS

A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:

1. Notify [Architect] [Construction Manager] [Owner] no fewer than [two] <Insert number> days in advance of proposed interruption of sprinkler service.
2. Do not proceed with interruption of sprinkler service without [Architect's] [Construction Manager's] [Owner's] written permission.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. 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.

B. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with [NFPA 13] [NFPA 13R].

C. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

D. High-Pressure Piping System Component: Listed for [250-psig minimum] [300-psig] working pressure.

E. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design wet-pipe sprinkler systems.

1. Available fire-hydrant flow test records indicate the following conditions:

a. Date: <Insert test date>.
b. Time: <Insert time> [a.m.] [p.m.]
c. Performed by: <Insert operator's name> of <Insert firm>.
d. Location of Residual Fire Hydrant R: <Insert location>.
e. Location of Flow Fire Hydrant F: <Insert location>.
f. Static Pressure at Residual Fire Hydrant R: <Insert psig>.
g. Measured Flow at Flow Fire Hydrant F: <Insert gpm>.
h. Residual Pressure at Residual Fire Hydrant R: <Insert psig>.

2. Sprinkler system design shall be approved by authorities having jurisdiction.

a. Margin of Safety for Available Water Flow and Pressure: [10] [20] <Insert number> percent, including losses through water-service piping, valves, and backflow preventers.
b. Sprinkler Occupancy Hazard Classifications:

1) Automobile Parking Areas: Ordinary Hazard, Group 1.
2) Building Service Areas: Ordinary Hazard, Group 1.
3) Electrical Equipment Rooms: Ordinary Hazard, Group 1.
4) Elevator Machine Room and Hoistway: Ordinary Hazard, Group 1.
5) General Storage Areas: Ordinary Hazard, Group 1.
6) Machine Shops: Ordinary Hazard, Group 2.
7) Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
8) Office and Public Areas: Light Hazard.

3. Minimum Density for Automatic-Sprinkler Piping Design:

a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.

4. Maximum protection area per sprinkler according to UL listing.
5. Maximum Protection Area per Sprinkler:

a. Office Spaces: 225 sq. ft..
b. Storage Areas: 130 sq. ft..
c. Mechanical Equipment Rooms: 130 sq. ft..
d. Electrical Equipment Rooms: 130 sq. ft..
e. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.

2.2 STEEL PIPE AND FITTINGS

A. Standard-Weight, Galvanized- Black-Steel Pipe: ASTM A53/A53M, , Grade B. Pipe ends may be factory or field formed to match joining method.

2.3 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Venus Fire Protection Ltd.

B. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

C. Pressure Rating for Automatic Sprinklers: 175-psig minimum.

D. Automatic Sprinklers with Heat-Responsive Element:

1. Early-Suppression, Fast-Response Applications: UL 1767.
2. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

E. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Ceiling Mounting: Chrome-plated steel, one piece, flat.
2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

F. Sprinkler Guards:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Tyco by Johnson Controls Company.
b. Victaulic Company.
c. Viking Corporation.

2. Standard: UL 199.
3. Type: Wire cage with fastening device for attaching to sprinkler.

2.4 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Flow Indicators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ADT Security Services, Inc.
b. Potter Electric Signal Company, LLC.
c. Viking Corporation.
d. WATTS.

2. Standard: UL 346.
3. Water-Flow Detector: Electrically supervised.
4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
5. Type: Paddle operated.
6. Pressure Rating: 250 psig.
7. Design Installation: Horizontal or vertical.

C. Pressure Switches:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Barksdale, Inc.
b. Detroit Switch, Inc.
c. Potter Electric Signal Company, LLC.
d. Tyco by Johnson Controls Company.
e. United Electric Controls Co.
f. Viking Corporation.

2. Standard: UL 346.
3. Type: Electrically supervised water-flow switch with retard feature.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design Operation: Rising pressure signals water flow.

2.5 PRESSURE GAUGES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AGF Manufacturing, Inc.
2. AMETEK, Inc.
3. Ashcroft Inc.

B. Standard: UL 393.

C. Dial Size: 3-1/2- to 4-1/2-inch diameter.

D. Pressure Gauge Range: 0- to 250-psig minimum.

E. Label: Include "WATER" label on dial face.

PART 3 EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.2 SERVICE-ENTRANCE PIPING

A. Connect sprinkler piping to water-service piping for service entrance to building. Comply with requirements for exterior piping in Section 211100 "Facility Fire-Suppression Water-Service Piping" for exterior piping.

B. Install shutoff valve, backflow preventer, pressure gauge, drain, and other accessories indicated at connection to water-service piping.

C. Install shutoff valve, check valve, pressure gauge, and drain at connection to water service.

3.3 WATER-SUPPLY CONNECTIONS

A. Connect sprinkler piping to building's interior water-distribution piping. Comply with requirements for interior piping in Section 221116 "Domestic Water Piping."

B. Install shutoff valve, backflow preventer, pressure gauge, drain, and other accessories indicated at connection to water-distribution piping.

C. Install shutoff valve, check valve, pressure gauge, and drain at connection to water supply.

3.4 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.

C. Install seismic restraints on piping. Comply with NFPA 13 requirements for seismic-restraint device materials and installation.

D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

E. Install unions adjacent to each valve in pipes NPS 2 and smaller.

F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

H. Install sprinkler piping with drains for complete system drainage.

I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

J. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.

K. Install alarm devices in piping systems.

L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13. In seismic-rated areas, refer to Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."

M. Install pressure gauges on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gauges with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal, and install where they are not subject to freezing.

N. Fill sprinkler system piping with water.

O. Install electric heating cables and pipe insulation on sprinkler piping in areas subject to freezing. Comply with requirements for heating cables in Section 210533 "Heat Tracing for Fire-Suppression Piping" and for piping insulation in Section 210700 "Fire-Suppression Systems Insulation."

P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

3.5 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.

I. Steel-Piping, Pressure-Sealed Joints: Join [lightwall] [and] [Schedule 5] steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

J. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

K. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

L. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

M. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

N. Copper-Tubing Grooved Joints: Roll rounded-edge groove in end of tube according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

O. Copper-Tubing, Pressure-Sealed Joints: Join copper tube and copper pressure-seal fittings with tools recommended by fitting manufacturer.

P. Extruded-Tee Connections: Form tee in copper tube according to ASTM F2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

Q. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

R. Plastic-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
2. CPVC Piping: Join according to ASTM D2846/D2846M Appendix.

3.6 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

3.7 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of[narrow dimension of] acoustical ceiling panels.

B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

C. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.

3.8 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Coordinate with fire-alarm tests. Operate as required.
6. Coordinate with fire-pump tests. Operate as required.
7. Verify that equipment hose threads are same as local fire department equipment.

B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.10 CLEANING

A. Clean dirt and debris from sprinklers.

B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.11 DEMONSTRATION

A. [Engage a factory-authorized service representative to train] [Train] Owner's maintenance personnel to adjust, operate, and maintain [specialty valves] [and] [pressure-maintenance pumps].

3.12 PIPING SCHEDULE

A. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with [threaded ends, cast-iron threaded fittings, and threaded] [grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved] joints.

B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

C. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be[one of] the following:

1. Standard-weight, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints

D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 4, shall be[one of] the following:

1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.

3.13 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings: Upright sprinklers.
2. Rooms with Suspended Ceilings: Concealed sprinklers.

3. Wall Mounting: Sidewall sprinklers.
4. Spaces Subject to Freezing: Upright sprinklers .

B. Provide sprinkler types in subparagraphs below with finishes indicated.

1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
2. Flush Sprinklers: Bright chrome, with painted white escutcheon.
3. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
4. Residential Sprinklers: Dull chrome.
5. Upright Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION 211313

SECTION 213116 - DIESEL-DRIVE, CENTRIFUGAL FIRE PUMPS

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:

1. Single-stage, split-case fire pumps.
2. Fire-pump accessories and specialties.
3. Flowmeter systems.
4. Fuel oil storage.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire pump.
2. Include rated capacities, operating characteristics, certified performance test curves, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each fire pump.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of fire pumps.
4. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
5. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of fire pump.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire pumps to include in emergency, operation, and maintenance manuals.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Environmental Conditions:

1. Ambient Temperature: 5 to 40 deg C.
2. Relative Humidity: Zero to 95 percent.
3. Altitude: Sea level to 1000 feet.

B. Pump Equipment, Accessory, and Specialty Pressure Rating: 175 psig minimum unless higher pressure rating is indicated.

C. 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.

2.2 ASSEMBLY DESCRIPTION

A. Description: Factory-assembled and -tested fire-pump and driver unit.

B. Finish: Red paint applied to factory-assembled and -tested unit before shipping.

C. NFPA Compliance: Comply with NFPA 20.

2.3 SINGLE-STAGE, SPLIT-CASE FIRE PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Aurora Pump; Pentair Ltd.
2. Peerless Pump Company.
3. Fairbanks

B. Pump:

1. Standard: , for split-case pumps for fire service.
2. Casing: Axially split case, cast iron with ASME B16.1 pipe-flange connections.
3. Impeller: Double suction, cast bronze, statically and dynamically balanced, and keyed to shaft.
4. Wear Rings: Replaceable bronze.
5. Shaft and Sleeve: Alloy-steel shaft with bronze sleeve.

    a. Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
    b. Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.

6. Mounting: Pump and driver shafts are horizontal, with pump and driver on same base.

C. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.

D. Capacities and Characteristics: See Fire Pump Schedule

2.4 FIRE-PUMP ACCESSORIES AND SPECIALTIES

A. Automatic Air-Release Valves: Comply with NFPA 20 for installation in fire-pump casing.

B. Circulation Relief Valves: UL 1478, bronze or cast iron, spring loaded; for installation in pump-discharge piping.

C. Inlet Fitting: Eccentric tapered reducer at pump suction inlet.

D. Outlet Fitting: Concentric tapered reducer at pump-discharge outlet.

E. Discharge Cone: type.

2.5 FLOWMETER SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Victaulic Company.

B. Description: UL-listed or FM-Approved, fire-pump flowmeter system with capability to indicate flow to not less than 175 percent of fire-pump rated capacity.

C. Pressure Rating: 175 psig minimum.

D. Sensor: Annubar probe, orifice plate, or venturi unless otherwise indicated. Sensor size shall match pipe, tubing, flowmeter, and fittings.

E. Permanently Mounted Flowmeter: Compatible with flow sensor, with dial not less than 4-1/2 inches in diameter. Include bracket or device for wall mounting.

2.6 FUEL OIL STORAGE

A. Comply with NFPA 30.

B. Day Tank: UL 142, freestanding, factory-fabricated fuel tank assembly, with integral, float-controlled transfer pump and the following features:

1. Containment: Integral rupture basin, with a capacity of 150 percent of nominal capacity of day tank.

a. Leak Detector: Locate in rupture basin and connect to provide audible and visual alarm in the event of day-tank leak.

2. Tank Capacity: As recommended by engine manufacturer.

3. Pump Capacity: Exceeds maximum flow of fuel drawn by engine-mounted fuel supply pump at 110 percent of rated capacity, including fuel returned from engine.
4. Low-Level Alarm Sensor: Liquid-level device operates alarm contacts at 25 percent of normal fuel level.
5. Piping Connections: Factory-installed fuel supply and return lines from tank to engine; local fuel fill, vent line, overflow line; and tank drain line with shutoff valve.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine equipment bases and anchorage provisions, with Installer present, for compliance with requirements and for conditions affecting performance of fire pumps.

B. Examine roughing-in for fire-suppression piping systems to verify actual locations of piping connections before fire-pump installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Fire-Pump Installation Standard: Comply with NFPA 20 for installation of fire pumps, relief valves, and related components.

B. Equipment Mounting:

1. Install fire pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Attach pumps to equipment base using anchor bolts.
3. Comply with requirements for vibration isolation and seismic control devices specified in Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."
4. Comply with requirements for vibration isolation devices specified in Section 210548.13 "Vibration Controls for Fire-Suppression Piping and Equipment."

C. Install fire-pump suction and discharge piping equal to or larger than sizes required by NFPA 20.

D. Support piping and pumps separately, so weight of piping does not rest on pumps.

E. Install valves that are same size as connecting piping. Comply with requirements for fire-protection valves specified in [Section 211200 "Fire-Suppression Standpipes."] [Section 211313 "Wet-Pipe Sprinkler Systems."]

F. Install pressure gages on fire-pump suction and discharge flange pressure-gage tappings. Comply with requirements for pressure gages specified in [Section 211200 "Fire-Suppression Standpipes."] [Section 211313 "Wet-Pipe Sprinkler Systems."]

G. Install piping hangers and supports, anchors, valves, gages, and equipment supports according to NFPA 20.

H. Install fuel system according to NFPA 20.

I. Install water supply and drain piping for diesel-engine heat exchangers. Extend drain piping from heat exchangers to point of disposal.

J. Install exhaust-system piping for diesel engines. Extend to point of termination outside structure. Install pipe and fittings with welded joints; install components having flanged connections with gasketed joints.

K. Install condensate-drain piping for diesel-engine exhaust system. Extend drain piping from low points of exhaust system to condensate traps and to point of disposal.

L. Install flowmeters and sensors. Install flowmeter-system components and make connections according to NFPA 20 and manufacturer's written instructions.

M. Electrical Wiring: Install electrical devices furnished by equipment manufacturers that are not factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.

N. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

3.3 ALIGNMENT

A. Align split-case pump and driver shafts after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.

B. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.

C. Align piping connections.

D. Align pump and driver shafts for angular and parallel alignment according to HI 1.4 and to tolerances specified by manufacturer.

3.4 CONNECTIONS

A. Comply with requirements for piping and valves specified in [Section 211200 "Fire-Suppression Standpipes."] [Section 211313 "Wet-Pipe Sprinkler Systems."] Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps and equipment to allow service and maintenance.

C. Connect relief-valve discharge to drainage piping or point of discharge.

D. Connect flowmeter-system meters, sensors, and valves to tubing.

E. Connect fire pumps to their controllers.

3.5 IDENTIFICATION

A. Identify system components. Comply with requirements for fire-pump marking according to NFPA 20.

3.6 FIELD QUALITY CONTROL

A. Test each fire pump with its controller as a unit. Comply with requirements for diesel-engine-driver fire-pump controllers specified in Section 262933 "Controllers for Fire-Pump Drivers."

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform the following tests and inspections[with the assistance of a factory-authorized service representative]:

1. After installing components, assemblies, and equipment, including controller, test for compliance with requirements.
2. Test according to NFPA 20 for acceptance and performance testing.
3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Components, assemblies, and equipment will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

G. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Hoses are for tests only and do not convey to Owner.

3.7 STARTUP SERVICE

A. [Engage a factory-authorized service representative to perform] [Perform] startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. <Insert startup steps if any>.

3.8 DEMONSTRATION

A. [Engage a factory-authorized service representative to train] [Train] Owner's maintenance personnel to adjust, operate, and maintain fire pumps.

END OF SECTION 213116

SECTION 220000 - PLUMBING GENERAL REQUIREMENTS

PART 1 GENERAL

1.1 DESCRIPTION

A. All work under this Section shall comply with the requirements of General Conditions, Supplemental Conditions, Special Conditions and Division 1 - General Requirements, and shall include all Sections of Division 22 and shall apply to all Work specified, indicated in the Drawings, and as required to furnish a complete installation of mechanical systems for the Project. Review all Sections of the Specifications for related work and coordinate the work of this Section with all other Sections.

B. Furnish all labor, services, materials, tools, equipment, appliances, facilities, transportation and incidental work and appurtenances required to furnish a complete and properly operating system.

C. The Contractor shall refer to the architectural interior details, floor plans, elevations, and the structural and other Contract Drawings and shall coordinate the work with that of the other trades to avoid interference. The plans are diagrammatic and show the general arrangement of the conduit, panels, transformers and equipment. All dimensions and existing conditions shall be the responsibility the Contractor. Before proceeding with work check and verify all dimensions.

D. The Contractor shall assume all responsibility for fitting of materials and equipment to other parts of equipment and structure. Make adjustments that may be necessary or as requested, in order to resolve space problems, preserve headroom, and avoid architectural openings, structural members and work of other trades. Where existing pipes, conduits and/or ducts prevent installation of new work as indicated, relocate, or arrange for relocation with the applicable trades, existing pipes, conduits and/or ducts.

E. Where the project involves interface with existing building and site systems, the Consultant has used reasonable care to identify existing utilities and services. The Contractor is responsible to thoroughly familiarize themselves with existing conditions and be aware that in some cases information is not available i.e. concealed conditions, which exist in the existing building affected by this work.

F. Documents do not represent to show or list every item to be provided. When an item not shown or listed, is necessary for proper operation of the system and/or equipment, the Contractor shall provide the item which will allow the system to function properly at no increase in Contract Sum.

G. Work shall include, but shall not be limited to, the following:

1. Tie-ins to the existing plumbing system.
2. Relocation of existing systems which interfere with new construction.
3. Removal of existing piping, fixtures, equipment and appurtenances, to be abandoned.
4. Coordinate maintenance of existing services during construction with Owner.
5. Special coordination of chases and shafts.
6. Hoisting and rigging required to complete work of this section.
7. Sleeves, inserts and hangers.
8. Equipment bases and supports.

9. Vibration isolators, and seismic restraints.
10. Motors.
11. Domestic Cold Water System
12. Domestic Hot Water and Recirculation System
13. Sanitary Waste and Vent System
14. Storm Sewer System
15. Grey Water System
16. Black Water Treatment
17. Rainwater Capture System
18. Condensate Drain System
19. Kitchen Waste and Vent System
20. Laboratory Waste and Vent System
21. Prime painting.
22. Equipment and major component identification.
23. Instruction manual and start up instructions.
24. Testing and balancing.
25. Commissioning.
26. Cleaning.

H. Related work specified elsewhere: The following work, unless otherwise noted is not included in this section shall be performed in other sections:

1. Fire Suppression Equipment. Division 21
2. Mechanical Equipment. See Division 23.
3. Integrated Automation. See Division 25
4. Excavation and backfill.
5. Concrete work, including concrete housekeeping pads and other pads and blocks for vibrating and rotating equipment, duct bank envelopes and cast in place manholes and handholes, except as part of an inertia base. See Division 3
6. Cutting and patching of masonry, concrete, tile and other parts of structure, with the exception of drilling for hangers and providing holes and openings in metal deck.
7. Flashing of wall and roof penetrations.
8. Installation of access panels in floors, walls, furred spaces or above ceilings
9. Partitions and Painting (except as specifically indicated) See Division.
10. Structural supports necessary to distribute loading from equipment to roof or floor, except as specified herein.
11. Foundation drainage systems and site drainage structures.
12. Paving

1.2 QUALITY ASSURANCE

A. General:

1. All equipment and accessories shall be the product of a manufacturer regularly engaged in its manufacturer.
2. All equipment and accessories shall be new and free from defects.
3. Supply all equipment and accessories in compliance with the applicable standards listed in this Section and with all applicable National, State and Local Codes.
4. All items of a given type shall be the product of the same manufacturer.
5. Install work by craftsmen skilled in trade involved and by apprentices as indicated in the general conditions. Rough work will be rejected.
6. The subcontractor must, within the last five years, prior to the bid opening, have successfully completed in a timely fashion at least three projects similar in scope and type to the required work.

B. Requirement of regulatory agencies:

1. In accordance with requirements of Division 1 and as specified herein.
2. Nothing in the Drawings or Specifications shall be construed to permit Work not conforming to applicable laws, ordinances, rules or regulations.
3. When Drawings or Specifications exceed requirements of applicable laws, ordinances, rules or regulations, Drawings and Specifications take precedence.
4. It is not the intent of Drawings and Specifications to repeat requirements of codes except where necessary for completeness or clarity.
5. If any of the requirements of the above are in conflict with one another, or with the requirements of these specifications, the most stringent requirements shall govern.

C. Green Building Performance Requirements

1. The Contractor shall implement practices and procedures to meet the Project's GREEN BUILDING requirements. The Contractor shall ensure that the requirements related to these goals, as defined in Section 018113: "Sustainable Design Requirements", and as specified in this Section, are implemented to the fullest extent. Substitutions or other changes to the work shall not be proposed by the Contractor or their sub-contractors if such changes compromise the stated GREEN BUILDING Performance Criteria.

1.3 APPLICABLE PUBLICATIONS

A. Materials and equipment shall be manufactured, installed and tested as specified in latest editions of applicable publications, standards, rulings and determinations of:

1. Local and state building, plumbing, mechanical, electrical, fire and health department codes.
2. American Society of Plumbing Engineers (ASPE)
3. American Water Works Association (AWWA)
4. American Society of Mechanical Engineers (ASME)
5. American Welding Society (AWS)
6. American National Standards Institute (ANSI).
7. American Society of Testing and Materials (ASTM).
8. Underwriter's Laboratories (UL).
9. National Fire Protection Association (NFPA).
10. Occupational Safety and Health Act (OSHA)

B. All materials and equipment shall be listed by Underwriters" Laboratories (UL), and approved by ANSI, and ASTM for intended service.

C. Most recent editions of applicable specifications and publications of the following organizations form part of these Contract Documents.

1. American National Standards Institute (ANSI)
2. American Water Works Association (AWWA)
3. American Society of Mechanical Engineers (ASME)
4. American Welding Society (AWS)
5. American Society of Testing and Materials (ASTM)
6. American Society of Plumbing Engineers (ASPE)
7. Underwriter's Laboratories (UL).
8. National Fire Protection Association (NFPA).
9. Occupational Safety and Health Act (OSHA)

1.4 DEFINITIONS

A. "Provide" means "furnish and install", complete, the specified material, equipment or other item and perform all required labor to make a finished and properly operational installation.

B. "Furnish" means to purchase and deliver to project site complete with all appurtenance and support. "Install" means to unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project

C. "Consultant" means "Prime Design Consultant". An individual or organization engaged by the owner or the architect to render professional engineering consulting services complementing or supplementing the architect's services concerning the content of the Mechanical, Electrical, Plumbing & Fire Protection sections of specifications.

D. "Owner" means the individual or entity with whom Contractor has entered into the Agreement for whom the Work is to be performed

E. "Construction Manager Advisor" or "CMA" means the Construction Manager that provides services to advise the Owner and Architect on design and materials decisions during the design and document development process. The CMA coordinates the entire design process using his skills and knowledge of construction to clarify cost and time considerations of design decisions, to advise on feasibility of single, multiple-contract or fast-track delivery systems, recommend the construction process, and to handle the bidding and award, as well as to manage the construction of the Project.

F. "Construction Manager Constructor" or "CMC" means the Construction Manager that in addition to acting as an advisor to the Owner during a design period, assumes responsibility for the construction of the Project. The CMC become contractually bound to provide the labor and material for the Project. The CMC may also serve as administrator of multiple prime contract construction; however, some states prohibit that practice.

G. General Contractor/ Prime Contractor means the contractor who contracts with a property owner and, in turn, employs a subcontractor or subcontractors to perform some of all of the work.

H. "Contractor" or "Subcontractor" means the trade contractor responsible for the work in this Division of the specification.

I. "Owner's Representative" means the Consultant, Engineer, or other Specialty Consultant retained by the Owner.

J. "RFI" means "Contractor's Request for Information".

K. "Above Grade": Not buried in the ground and not embedded in concrete slab on ground.

L. "Accessible": Ability to perform recommended maintenance without removal of services or equipment and requiring no special platforms.

M. "Actuating" or "Control" Devices: Automatic sensing and switching devices such as thermostats, pressure, float, electro-pneumatic switches and electrodes controlling operation of equipment.

N. "Below Grade": Buried in the ground or embedded in concrete slab on ground.

O. "Concealed": Embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures. In general, any item not visible or directly accessible.

P. "Connect": Complete hook-up of item with required service.

Q. "Exposed": Not installed underground or "concealed."

R. "Indicated," "Shown" or " "Noted": As indicated, shown or noted on Drawings or Specifications.

S. "Install": To erect, mount and connect complete with related accessories.

T. "Piping": Pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation, and related items.

U. "Reviewed," "Satisfactory" or "Directed": As reviewed, satisfactory, or directed by or to Architect/Engineer/Owner.

V. "Rough-In": Provide all indicated services in the necessary arrangement suitable for making final connections to fixture or equipment.

W. "Shall": An exhortation or command to complete the specified task.

X. "Similar" or "Equal": Of base bid manufacture, equal in materials, weight, size, design, and efficiency of specified products.

Y. "Supply": To purchase, procure, acquire and deliver complete with related accessories.

Z. "Typical" or "Typ": Exhibiting the qualities, traits, or characteristics that identify a kind, class, number, group or category. Of or relating to a representative specimen. Application shall apply to all other similarly identified on plan or detail.

AA. "Will": A desire to complete the specified task. Allows some flexibility in application as opposed to "Shall."

BB. "Wiring": Raceway, fittings, wire, boxes and related items.

CC. "Work": Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.

DD. Reference by abbreviation may be made in the specifications and the Contract Drawings for Mechanical and Electrical Work in accordance with the following list:

1. HVAC Heating, Ventilating and Air Conditioning
2. GC General Contractor
3. USS United States Standards
4. ASTM American Society of Testing Materials
5. ASA American Standards Association
6. ADA: Americans with Disabilities Act.
7. ANSI: American National Standards Institute.
8. HP: Horsepower.
9. ICEA: Insulated Cable Engineers Association

10. IEEE: Institute of Electrical and Electronic Engineers.
11. NEMA: National Electrical Manufacturers' Association.
12. NETA: National Electrical Testing Association, Inc.
13. NFPA: National Fire Protection Association.
14. OSHA: Occupational Safety and Health Act.
15. ABS: Acrylonitrile-butadiene-styrene plastic.
16. CPVC: Chlorinated polyvinyl chloride plastic.
17. PE: Polyethylene plastic.
18. PVC: Polyvinyl chloride plastic.
19. EPDM: Ethylene-propylene-diene terpolymer rubber.
20. NBR: Acrylonitrile-butadiene rubber.
21. UBC: Uniform Building Code.
22. UL: Underwriters' Laboratories,

1.5 SCOPE

A. Perform work and provide material and equipment as shown on the drawings and/or as specified and/or as indicated in this section of the specifications. Completely coordinate all work of this section with work of other trades and provide a complete and fully functional installation

B. Drawings and Specifications form complimentary requirements; provide work specified and not shown, and work shown and not specified as though explicitly require by both. Although work is not specifically shown or specified, provide supplementary or miscellaneous items, appurtenances, devices and materials obviously necessary for sound, secure and complete installation.

C. Give notices, file plans, obtain permits and licenses, pay fees and back-charges, and obtain necessary approvals from authorities that have jurisdiction as required to perform work in accordance with all legal requirements and with Specifications, Drawings, Addenda and Change Orders, all of which are part of Contract Documents.

D. Contractor shall be responsible with obtaining all the final inspection as required by Local Code and ordinances.

1.6 CONTRACT DOCUMENTS

A. Listing of Documents does not limit responsibility of determining full extent of work required by these Contract Documents. Refer to the Consultant's, Plumbing, Electrical, HVAC and Fire Protection, Structural, Site Utility and all other drawings and other sections that types of and work of other trades with which work of this section must be coordinated

B. Except where modified by a specific notation to the contrary; it shall be understood that the indication and/or description of any item, in the drawings or specifications or both, carries with it the instruction to furnish and install the item, regardless of whether or not this instruction is explicitly stated as part of the indication or description.

C. Items referred to in singular number in Contract Documents shall be provided in quantities necessary to complete work.

D. Drawings are diagrammatic. They are not intended to be absolutely precise; they are not intended to specify coordinated routings and component. The purpose of the document is to indicate systems concept, the main components of the systems, and the approximate geometric relationships. Based on the systems concept, the main components and the approximate geometrical relationships, the contractor shall provide all other components and materials necessary to make the systems fully complete and operational

E. Information and components shown on riser diagrams, but not shown on plans, and vice versa, shall apply and be provided as if expressly required on both

F. Data that may be furnished electronically by the Consultant is diagrammatic. Such electronically furnished information is subject to the same limitation of precision as heretofore described. If furnished, such data is for convenience and generalized reference, and shall not be substitute for Consultant's sealed or stamped construction documents.

1.7 ELECTRONIC MEDIA FILES

A. Construction drawings for this project have been prepared utilizing AutoCAD 2013.

B. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.

C. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Release" form provided by Buro Happold.

D. The electronic contract documents can be used to assist in the preparation of shop drawings and as-built drawings however the electronic media files obtained from Buro Happold are for reference only. The information may not be used in whole or in part for any other project.

E. The drawings prepared for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.

F. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.

G. The information is provided to expedite the project and assist the Contractor with no guarantee by Buro Happold as to the accuracy or correctness of the information provided. Buro Happold accepts no responsibility or liability for the Contractor's use of these documents.

1.8 REVIEW OF CONTRACT DOCUMENTS AND SITE

A. With the submission of his bid, Contractor shall give written notice to the Owner of any materials or apparatus believed inadequate or unsuitable, in violation of laws, ordinances, rules or regulations of Authorities having jurisdiction, and any necessary items of work omitted. In the absence of such written notice it is mutually agreed that the Contractor has included the cost of all required items in his proposal for a complete project.

B. Contractor shall acknowledge that he has examined the Plans, Specifications and Site, and from his own investigations he has satisfied himself as to the nature and location of the work; the general and local conditions, particularly those bearing upon transportation, disposal, handling and storage of materials; availability of labor, water, electric power, roads and uncertainties of weather; the conformation and condition of the ground; the character, quality and quantity of surface and subsurface materials to be encountered; the character of equipment and facilities needed preliminary to and during the execution of the work; all federal, state, county, township and municipal laws, ordinances and regulations particularly those relating to employment of labor, rates of wages, and construction methods; and all other matters which can in any way affect work or the cost thereof under this Contract. Any failure by the Contractor to acquaint himself with the available information concerning these conditions will not relieve him from the responsibility for estimating properly the difficulty or cost of successfully performing the work.

C. The location and elevation of the underground utilities, such as sewers, electrical power, water piping, steam and steam condensate return piping, conduit, etc., is as exact as can be determined from available information and its accuracy cannot be guaranteed. Exact location and elevation of these services shall be verified prior to excavation or installation of any portion of the work indicated. Exercise special care when excavating at or near the general location of underground utilities to avoid damage to the utility services. The Contractors is responsible to insure worker safety.

D. The contractor shall also acknowledge having been to the site and examined conditions under which work must be performed including preparatory work done under other Sections or other Contracts or by the Owner. Report conditions to the Consultant. Do not proceed until defects have been corrected and conditions are satisfactory. Commencement of work shall be construed as complete acceptance of existing conditions and preparatory work.

E. Owner assumes no responsibility for any understanding or representation made during or prior to the negotiation and execution of this Contract unless such understanding or representations are expressly stated in the Contract, and the Contract expressly provides that the responsibility, therefore, is assumed by the Owner.

1.9 DISCREPANCIES IN DOCUMENTS

A. Where Drawings or Specifications conflict or are unclear, advise the Consultant in writing before award of Contract. Otherwise, Consultant's interpretation of the Contract documents shall be final, and no additional compensation shall be permitted due to discrepancies or ambiguousness thus resolved.

B. Where Drawings or Specifications do not coincide with manufacturer's recommendations, or with applicable codes and standards, alert the Consultant in writing before installation. Otherwise, make changes in installed work as the Consultant requires within Contract Price.

C. If the required material, installation, or work can be interpreted differently from drawing to drawing, or between drawings and specification, this contractor shall provide material, installation, or work which is of higher standard.

D. It is the requirement of these documents to have contractor provide systems and components that are fully complete and fully operational and fully suitable for intended use. There may be situations in the documents where insufficient information exists to precisely describe a certain component or subsystem, or the routing of the component or its coordination with other building elements. In cases such as this, where the contractor has failed to notify the Consultant of the situation in accordance with paragraph (A) above, the contractor shall provide specific component or subsystem with all parts necessary for the intended use, fully complete and operational, and installed in workmanlike manner either concealed or exposed per the design intent.

E. In cases covered by paragraph (D) above, where the contractor believes he needs the engineering guidance, he shall submit a sketch identifying his proposed solution and the Consultant shall review, note if necessary, and approve the sketch.

1.10 MODIFICATION IN LAYOUT

A. Plumbing, Electrical, HVAC, and Fire Protection Drawings are diagrammatic. They indicate general arrangements of mechanical and electrical systems and other work. They do not show all offsets required for coordination nor do they show exact routings and locations needed to coordinate with structure and other trades to meet the Consultant's requirements

B. In order to obtain the Architect's desired aesthetics in spaces used by building occupants; prior to installation of visible materials, finishes and equipment (including access panels, review Consultant's Drawings for desired locations and where not definitely indicated, request information from the Architect/Consultant.

C. Check Contract Drawings, as well as Shop Drawings, of all subcontractors to verify and coordinate spaces in which work of this section will be installed

D. Maintain maximum headroom at all locations. All conduit, piping, duct and associated components to be as tight to underside of structure as possible.

E. Make reasonable modifications in layout and components to prevent conflict with work of other trades and to coordinate according to Paragraphs A, B, C, and D above. Systems shall be run in an organized and rectilinear fashion.

F. Where conflicts or potential conflict exists and engineering guidance is desired, submit sketch of proposed resolution to the Consultant for review and approval

1.11 RFIs

A. If the RFI is a request to resolve a conflict or a un-clarity, or a request for additional detail, Contractor's RFI shall include a sketch or equivalent description of Contractor's proposed solution, in accordance with paragraph 1.9(E) above

1.12 PROJECT COMMUNICATION

A. The specification references communication and submittal of information and documents by the Contractor to the Engineers of Record and CM or vice versa. In all cases such communication shall be submitted to the CM who will review it before forwarding to the relevant party for review and response.

B. If the information provided is not in conformance with the specification the CM shall return it to the relevant Contractor for re-submission. The time taken for this process shall be factored into all work schedules and submissions.

1.13 MEASUREMENTS

A. Contractor shall base all his measurements, both horizontal and vertical from established benchmark. All work shall agree with these established lines and levels. He shall verify all measurements at site; and check the correctness of same as related to the work.

1.14 MATERIALS AND WORKMANSHIP

A. Materials shall be new, meet detailed requirements of the Contract Documents and be identifiable as being specified or substitute products.

B. Materials which do not conform to the requirements of the Contract Documents, are not equal to approved samples or are unsatisfactory or unsuited to the purpose for which they are intended, will be rejected.

C. All work shall be performed in the best and most workmanlike manner by tradesmen skilled in their respective trades and properly licensed.

D. All equipment shall be installed in accordance with the recommendation of the manufacturer.

E. Defective work, whether the result of poor workmanship, use of defective materials, damage through carelessness, or other cause shall be removed within ten (10) days after written notice is given by the Owner's Representative and the work shall be re-executed by the Contractor. The fact that the Owner's Representative may have previously overlooked such defective work shall not constitute total or partial acceptance of it.

F. In no case shall a Bidder base his bid on a class of material or workmanship less than that required by the contract documents nor the governing codes and ordinances.

1.15 CHECKING AND TESTING EQUIPMENT BY CONTRACTORS AND MANUFACTURER'S REPRESENTATIVE

A. All equipment shall be installed in strict accordance with manufacturer's instructions. During construction request supervisory assistance from equipment manufacturer's representatives so the equipment will be correctly installed. After installation, request the Owner's Representative to inspect and see the equipment is in proper working order.

B. Manufacturer's representative shall review the overall system design relative to the proper application of his equipment in the particular system. He shall note conduit, wiring, control, location, and other relevant relationships, and furnish appurtenances necessary for satisfactory operation.

C. Before final payment is issued the following shall be complete:

D. The Contractor's representative shall submit to the CM a signed statement certifying:

1. The equipment is properly installed and ready for operation

2. The owner's maintenance representatives have been thoroughly trained
3. Maintenance and operation manuals issued and accepted by the Owner's Representative.

1.16 TEMPORARY FACILITIES

A. Temporary water and waste per Division 1 requirements.

B. All temporary facilities shall be removed at completion of project.

1.17 SUBMITTALS

A. This paragraph supplements Division 1.

B. Definitions:

1. Shop Drawings are information prepared by the Contractor to illustrate portions of the work in more detail than shown in Contract Documents.
2. Coordination Drawings are detailed, large scale layout Shop Drawings showing Electrical, HVAC, Plumbing and Fire protection work superimposed in order to identify conflicts and ensure inter-coordination of Electrical, Mechanical, Plumbing, Fire Protection, Structural and other work.

C. Submittal Cover Sheet

1. Shop drawing submittal for each product shall include the copy of following cover sheet completely filled out. Incomplete or incorrect cover sheet submittal shall constitute reason for rejection.
2. Shop drawings shall be submitted according to specification section with a separate cover sheet completed for each product, rather than one cover sheet for multiple products, whether or not supplied by one manufacturer or vendor.
3. In order to maintain the shop drawing review schedule described hereafter, it is important that all submittals include a completed submittal cover sheet for each type of equipment submitted. This requirement will be enforced by the engineer.

SHOP DRAWING COVER SHEET			
PROJECT		CONTRACTOR	
DIVISION NO:		SECTION NO:	
DESCRIPTION:			
CONTRACT DRAWING REFERENCE NO:			
EQUIPMENT TAG:			
SUBMISSION (CIRCLE ONE): I II III IV			
DATE:			
INFORMATION AND CHECKLIST		REPLY	COMMENTS
4.	Contractor's Log # ID		
5.	Name, address, and phone number of supplier		
6.	Are all specified or scheduled items included and exactly match scheduled/specified items.	Yes No	
7.	Is this item a substitution?	Yes No	
8.	Are deviations clearly identified?	Yes No	
9.	Does this equipment fit space	Yes No	

	shown on construction documents, coordination drawings, and actual field conditions?		
10.	Has support, erection, weights, and installation been coordinated with all trades?	Yes No	
11.	Does the proposed installation void warranties and/or violate UL or code requirements?	Yes No	
12.	Does this material/equipment add expense to any other trade or project costs?	Yes No	
13.	Does equipment require interface with other trades? Lists divisions and specifics requiring coordination?	Yes No	
14.	Is control interface coordinated?	Yes No	
15.	List electrical characteristics (V/Ph/A)	Yes No	

D. Submittals procedure and format

1. Identify each item by manufacturer, brand, trade name, number, size, rating, or whatever other data is necessary to properly identify and check materials and equipment.
2. Identify each submittal item by reference to Specification Section paragraph in which item is specified, or Drawing and Detail number, identify deviations, if any.
3. Organize submittals in same sequence as they appear in Specification Sections, articles or paragraphs.
4. Shop Drawings shall show physical arrangement, construction details and finishes:
5. Drawings shall be drawn to scale and dimensioned where applicable.
6. Catalog cuts and published material shall be included to supplement scale drawings.
7. Internal wiring diagrams of equipment shall show wiring as actually furnished for this project, with all optional items clearly identified as included or excluded. Clearly identify external wiring connections. Identify and obliterate superfluous material.
8. Submittal literature, drawings and wiring diagrams shall be specifically applicable to this Project and shall not contain extraneous material or optional choices. Clearly mark literature to indicate the proposed item. Submittals shall include, but not be limited to those items listed in individual Sections.
9. Include all physical and performance data, including materials, manufacturer's names, model numbers, weights, sizes, capacities, performance curves, finishes, colors, accessories, installation instructions, and all other data required to completely describe equipment and to indicate complete compliance with Specifications and Drawings.
10. Include with complete submittals above, complete, large scale, dimensioned Shop Drawings, certified by manufacturer, of all major equipment.
11. Time Schedules for Submission and Ordering: The Contractor shall prepare, review and coordinate his schedule of submissions carefully, determining the necessary lead time for preparing, submitting, checking, ordering and delivery of all materials and equipment for timely arrival. The Contractor shall be responsible for conformance with the overall construction schedule.
12. Submittals shall be reviewed for general compliance with Specifications only. The Contractor shall be responsible for deviations from the Drawings or Specifications and for errors or omissions of any sort in submittals.

13. The Contractor shall add and sign the following paragraph on all equipment and materials submitted for review:
14. "It is hereby certified that the equipment, material shown and marked in this submittal is that proposed to be incorporated into the project; is in compliance with the Contract Drawings and Specifications and can be installed in the allocated spaces."
15. Failure to add the above written statement for compliance shall result in return of submittals to be reviewed.
16. The Contractor shall verify dimensions of equipment and be satisfied per Applicable Code Requirements for fit prior to submitting Shop Drawings for approval.
17. Where current limiting devices are specified, submit technical data to substantiate adequate protection of equipment cascaded downstream. Submittals shall not be reviewed unless supporting calculations and data are submitted therewith.
18. For any material specified to meet Underwriters' Laboratories, Inc. (UL) or trade standards, furnish the manufacturer's or vendor's certification that the material furnished for the work does in fact equal or exceed such Specifications.
19. Submit on all materials and equipment even if they are as specified or shown on the Drawings.
20. Equipment Floor Plans: After approval of material is secured, prepare a floor plan of each electrical equipment closet enclosures and room drawn to, scale of 1/2 inch equals 1 foot, and submit for approval in the same manner as for Shop Drawings. The layout drawings shall be to exact scale, and indicate location of all electrical equipment.
21. Resubmittals shall include written response to each item in review of previous submittal.

E. Acceptable Manufacturers: The Consultant's mechanical/electrical design for each product is based on the single manufacturer listed in the schedule or shown on the drawings. In Part 2 of the specifications certain Alternate Manufacturers are listed as being acceptable. These are acceptable only if, as a minimum, they:

1. Meet all performance criteria listed in the schedules and outlined in the specifications.
2. Have identical operating characteristics to those called for in the specifications. For example, a two stroke diesel generator will not be acceptable if a four stroke is specified.
3. Fit within the available space it was designed for, including space for maintenance and component removal, with no modification to either space or product. Clearances to walls, ceilings and other equipment will be least equal to those shown on the design drawings. The fact that a manufacturer's name appears as acceptable shall not be taken to mean that the Consultants have determined that the manufacturer's products will fit within the available space. This determination is solely the responsibility of the contractor.
4. Products must adhere to all Consultant's considerations including, but not limited to: being of same color as the product scheduled or specified, fitting within Consultant's enclosures and details, and for diffusers, lighting and plumbing fixtures - being the same size and physical appearance as scheduled or specified products.
5. The proposed substitution shall meet performance and quality of scheduled equipment, whether it requires additional accessories or not.
6. There is no increase in Contract Sum and this Contractor shall pay for any additional work required by other trades as a result of the substitution.
7. Submit all equipment sound power and pressure level for review and compliance.

F. Required Use of Acceptable Manufacturers on his Project: Substitution of products other than those of the Acceptable Manufacturers specified herein shall not be made. Only the specified items or the comparable product by one of the specified Alternate Manufacturers shall be submitted. Products by other manufacturers shall not be used on this project.

G. Deviations:

1. Concerning deviations other than substitutions, proposed deviations from Contract Documents shall be requested individually in writing whether deviations result from field conditions, standard shop practice or other cause. Submit letter with transmittal of shop drawings, which flags deviation to the attention of the Consultants.
2. Without letters flagging the deviation to the Consultants, it is possible that the Consultants may not notice such deviation or may not realize its ramifications. Therefore, if such letters are not submitted to the Consultants, the contractor shall hold the Consultants and his consultants harmless for any adverse consequences resulting from the deviations being implemented. This shall apply regardless of whether the Consultants has reviewed or approved shop drawings containing the deviation, and will be strictly enforced.
3. Approval of proposed deviations, if any, will be made at discretion of Consultants.
4. Any of the approved deviations shall be deemed acceptable to this Contractor with no change in contract sum, unless the Consultant also receives a written notice to the contrary.

H. Submittal Notations: Submittals will be returned from the Consultants marked as illustrated below:

1. REVIEWED: "Reviewed and found generally acceptable. Minor deviations may be noted. No further submittal required if notations are complied with."
2. REVIEWED, DEVIATIONS NOTED; REVISE AND RESUBMIT: "Submittal contains deviations which must be corrected and confirmed by a new submittal."
3. REJECTED: "Submittal is incorrect to such an extent that the material is unacceptable, or in incomplete to such an extent that a review cannot be made. Resubmit in accordance with requirements of the Contract Documents."

I. Responsibility:

1. Intent of Submittal review is to check for capacity, rating, and certain construction features. Contractor shall ensure that the work meets the requirements of Contract Documents regarding information that pertains to fabrication processes or means, methods, techniques, sequences and procedures of construction; and for coordination of work of this or other Sections. Work shall comply with submittals marked "REVIEWED" to the extent they agree with the Contract Documents. Submittal review shall not diminish responsibility under this Contract for dimensional coordination, quantities, installation, wiring, supports and access for service, nor shop drawing errors or deviations from requirements of Contract Documents. The Consultant's noting of some errors while overlooking the others will not excuse the contractor from proceeding in error. Contract Documents are not limited, waived nor superseded in any way by review.
2. INFORM SUBCONTRACTORS, MANUFACTURERS, SUPPLIERS, ETC. OF SCOPE AND LIMITED NATURE OF REVIEW PROCESS AND ENFORCE COMPLIANCE WITH CONTRACT DOCUMENTS.

J. Schedule: Incorporate shop drawing review period into construction schedule so that Work is not delayed. Contractor shall assume full responsibility for delays caused by not incorporating the following review time requirements into his project schedule. Working days listed reference the time in Engineer's office. It does not include transmittal time or review time of Contractor or the Consultant. Allow at least 10 working days, exclusive of transmittal time, for review each time shop drawing is submitted or resubmitted with the exception that 20 working days, exclusive of transmittal time, are required for the following:

1. Coordination Drawings.
2. If more than five shop drawings of a single trade are received in one calendar week.

1.18 List of Proposed Equipment and Materials:

A. Within four weeks of Award of Contract and before ordering materials or equipment, submit complete list of materials and equipment and indicate manufacturer's name, addresses and telephone numbers. No consideration will be given to partial lists submitted out of sequence.

B. If the List of Materials and Equipment is not received within the prescribed time limit, provide the first-named manufacturer for all material and equipment on this project.

1.19 EQUIPMENT SUPPLIER'S INSPECTION Modify list of equipment as required.

A. The following equipment shall not be placed in operation until a competent installation and service representative of the manufacturer has inspected the installation and certified that the equipment is properly installed, adjusted and lubricated; that preliminary operating instructions have been given; and that the equipment is ready for operation:

B. Modify list to suit systems used

C. Pressure Boosting Pumps

D. Water Heater Equipment

E. Solar Water Heating System

F. Uninterrupted Power Supply

G. Fire Seal Systems

H. Seismic Restraints and Equipment Bracing

I. Contractor shall arrange for and obtain supplier's on-site inspection(s) at proper time(s) to assure each phase of equipment installation and/or connection is in accordance with the manufacturer's instructions.

J. Submit copies of start-up reports to the Engineer and include copies IN THE Project Close-Out and Owner's Operation and Maintenance Manuals.

K. Refer to each Section for specific equipment inspection requirements and procedure.

1.20 COORDINATION DRAWINGS:

A. A single set of coordination drawings shall be mutually prepared by all mechanical and electrical trades.

B. The initiation of these drawings begins with Sheet Metal Subcontractor.

C. The Sheet Metal Subcontractor shall prepare a complete set of electronic background drawings at scale not less than 3/8" equals 1'-0", showing structure and other information as needed for coordination. He shall show sheet metal layout thereon. These will be Coordination Drawings.

D. Each of the mechanical, electrical, plumbing and other specialty trade shall add its work to these background drawings with appropriate elevations and grid dimensions. Specialty trade information is require for fan rooms and mechanical rooms, horizontal exits from duct shafts, crossovers, and for spaces in and above ceilings where congestion of work may occur such as corridors, and even entire floors. Drawings shall indicate horizontal and vertical dimensions, to avoid interference with structural framing, ceilings, partitions, and other services.

E. Each specialty trade shall sign and date each coordination drawing. Return drawing to the Sheet Metal Subcontractor, who shall route them sequentially to all specialty trades.

F. Where conflicts occur with placement of materials of various trades, the Sheet Metal Subcontractor will be responsible to coordinate the available space to accommodate all trades. Any resulting adjustments shall be initialed and dated by specialty trade. The Sheet Metal Subcontractor shall then final date and sign each drawing. If he cannot resolve conflicts, the decision of the General Contractor/Construction Manager shall be final.

G. A Subcontractor who fails to promptly review and incorporate his work on the drawings shall assume full responsibility of any installation conflicts affecting his work and of any schedule ramifications.

H. Sheet Metal Subcontractor shall make prints of all coordination drawings. Fabrication shall not start until such transparencies of completed coordination drawings are received by the Consultant/Engineer and have been reviewed and approved.

I. The review of coordination drawings shall not diminish responsibility under this Contract for final coordination of installation and maintenance clearances of all systems and equipment with the other trades, structural and other work.

J. After review:

1. After review of coordination drawings, the method used to resolve interferences not previously identified shall be as in "MODIFICATIONS IN LAYOUT" above.
2. All changes to reviewed coordination drawings shall be in writing by the Consultants/Engineer prior to start of work in affected area.

K. Distribution of Coordination Drawings:

1. The Sheet Metal Subcontractor shall provide the following distribution of documents:

    a. One sepia (reproducible) of each Coordination Drawing to each specialty trade and affected Contractor for their use.
    b. One reproducible of each Coordination drawing to Owner.
    c. One sepia (reproducible) of each coordination drawing to the General Contractor/Construction Manager.
    d. The above documents can be submitted as electronic media upon agreement of all parties.

L. ALL FIREWALLS AND SMOKE PARTITIONS SHALL BE HIGHLIGHTED ON COORDINATION DRAWINGS FOR APPROPRIATE COORDINATION.

M. The main paths of egress and for equipment removal from main mechanical and electrical rooms must be clearly shown on coordination drawings.

N. Coordination Drawings shall include, but not limited to:

1. Plumbing systems, piping and equipment.
2. HVAC piping, systems and equipment.
3. Control systems.
4. Electrical distribution, systems and equipment.
5. Lighting systems and fixtures.
6. Sheet metal work, components and accessories, costs and boxes in terminals, etc.
7. Fire protection and sprinkler system, piping and heads.
8. Structural.
9. Electrical Equipment Room layouts.
10. Environmental Rooms and associated refrigeration/heating systems.
11. Partition/room layout.
12. Ceiling tile and grid.
13. Access panels.
14. Smoke and fire dampers.
15. Roof drain piping.
16. Major electrical conduit runs, panel-boards, feeder conduit and racks of branch conduit.
17. Above ceiling miscellaneous metal.
18. Heat tracing of piping.
19. Minimum access space requirements for all equipment for both installation and maintenance.

1.21 COORDINATION BUILDING INFORMATION MODEL (BIM)

A. General Requirements:

1. The General Contractor shall appoint a BIM Coordination Manager to prepare a BIM Execution Plan developed specifically for the project, and based on the Computer Integrated Construction (CIC) Research Program's BIM Planning procedures. The BIM Execution Plan will establish the protocols, expected levels of development, and authorized uses of Building Information Models on this Project and assigns specific responsibility for the development of each Model Element to a defined Level.

B. Services to be modelled:

1. All piping (above ½") and all equipment shall be modelled based on the proposed submitted products. The model may be used for production of shop drawings.

C. Clash Detection:

1. Perform three-dimensional component conflict analysis as part of coordination process with all other trades, including but not limited for Mechanical, Plumbing, Fire Protection and Fire Alarm. Resolve component conflicts prior to submittal of shop drawings. Indicate where conflict resolution requires modification of design requirements by Construction Manager.

D. 3D Assets:

1. The contractor shall hand over all digital data files related to the BIM execution plan at the end of the construction process, including all, but not limited to the shop drawings and as built conditions.

1.22 REGULATIONS, CODES, PERMITS, AND FEES

A. Conform to all rules, regulations, standards, ordinances and laws of local, state, and Federal governments and other authorities that have legal jurisdiction over the site.

B. Prior to commencement of work, notify State and applicable authorities as required and submit all of the applicable notifications for construction, operation and demolition. Secure required permits and inspections from any of the authorities having jurisdiction, for this work and pay for all fees required for permits, inspections and review, including special agency construction.

C. Include all utility and local building department charges for providing temporary and permanent electric services to buildings.

D. Provide Owner, Owner's Representative and Inspectors from any of the authorities / agencies having jurisdiction access to work at all times.

E. Contractor shall be responsible for all law violations caused by the work under this Division. Notify Construction Manager in writing when a discrepancy occurs between code requirements and work shown on drawings and resolve matter before proceeding with work.

F. When requirements cited in this specification conflict with each other or with Contract Documents, most stringent shall govern work. Consultants may relax this requirement when such relaxation does not violate ruling of authorities that have jurisdiction. Approval for such relaxation shall be obtained in writing.

G. Make corrections in the work as required by the Owner's Representative or Inspector to pass local regulations.

H. Contractor shall deliver to the Construction Manager any and all certificates of inspections, permits, and approvals. Contractor shall submit final inspection certificates signed by governing authorities to the Owner.

I. Make all necessary submissions to the Department of Environmental Protection, Bureau of Air Resources and Management, Department of Labor and Industry and other agencies having jurisdiction. Pay all required fees for review, registration and sign off.

1.23 OPERATING AND MAINTENANCE MANUALS

A. Obtain at time of purchase of equipment, three copies of operation and maintenance manuals for all items. Assemble literature in coordinated "D" ring notebooks. All information shall also be provided in electronic PDF format. Divide the manuals into three sections or books as follows:

B. System General Description and Information. Section shall include a general description of the systems used and contain names and addresses of manufacturers and local representatives who stock or furnish or repair parts for items or equipment. List of all major equipment as installed and include model number, capacities, nameplate data and manufacturer's location and purchase order information. Include in the manuals, parts catalogs for each item of equipment furnished with the components identified by number for replacement ordering. This section shall also include:

1. Letters from manufacturers certifying their supervision of equipment installation and startup procedures as required.
2. Factory certification test certificates.
3. Equipment test certificates.

C. Operation, Start-up and Shutdown Procedures. Section shall include directions for and sequence of operation for each item of the Plumbing, Mechanical and Electrical systems.

D. Provide a step-by-step write-up and video of the operation, start-up and shut down procedures for all major equipment.

E. Problems, Solutions and Troubleshooting. Section shall include detailed procedures to be followed in case of equipment or system malfunctions. Include manufacturer's printed troubleshooting procedures into the operating manual for reference.

F. Preventative Maintenance. Section shall include preventative maintenance requirements and schedule for each piece of equipment.

G. Furnish three copies of manuals to the Consultant for approval and distribution to Owner. Deliver manuals no less than 30 days prior to project close-out or 10 days prior to commissioning whichever is sooner.

1.24 RECORD DOCUMENTS (AS-BUILTS)

A. As work progresses and for duration of Contract, maintain current complete and separate sets of prints of Contract drawings at job site. Record work completed and all changes from original Contract Drawings clearly and accurately including work installed as a modification or addition to original design. Include actual location of existing utilities if they differ from design documents.

B. Underground utility services, both inside and outside of buildings, shall be dimensioned from permanent structures or benchmark. Utility services outside of buildings shall also show depth of burial with reference to the finished ground floor elevation.

C. Drawings shall show record condition of details, sections, riser diagrams, control changes and correction to schedules. Schedules shall show actual manufacturer and make and model numbers of final equipment installation. All elements shall be dimensioned from grid lines or benchmarks and all elevations shall be noted. Construction notes (such as component numbers, conflict notes, etc.) shall be removed and the drawings shall clearly be noted in the title block as being as-built drawings.

D. At the completion of the project, prepare a complete set of record drawings, showing all systems actually installed, as well as electronic files on latest CAD version.

E. The design tracings will be made available for Contractor's copying, at his expense, into reproducible to serve as background drawings. The quantity of design tracings, which are made available shall in no way be interpreted as setting a limit to the number of drawings necessary to show required information. Contractor's professional draftsperson shall transfer changes to record files and then submit the electronic files and three sets of prints to the Consultant for comments as to compliance with this section.

F. The record set reproducible, as corrected and recorded by the Contractor, shall be submitted to the Owner's Representative for approval prior to authorization for final payment. Record drawings shall be certified as to their correctness by the signature of the Contractor, and shall be stamped or otherwise identified as record drawings. THE CONSULTANT WILL NOT CERTIFY THE ACCURACY OF THE RECORD DRAWINGS - THIS IS THE SOLE RESPONSIBILITY OF THE CONTRACTOR.

G. Each trade shall submit a record set for approval by the building department in a form acceptable to the department, when required by the jurisdiction. Such drawing format size changes, and supplemental information required for the submittal are the requirement of the contractor.

1.25 COOPERATION BETWEEN TRADES

A. Cooperate with all other Divisions performing work on this project as necessary to achieve a complete neatly fitted installation for each condition. Consult the Drawings and Specifications to determine nature and extent of work specified in other Divisions that adjoins or attaches to the work of this Division. Confer with other Divisions at the site to coordinate this work with theirs in view of job conditions to the end that interferences may be eliminated and that maximum head room and clearance may be obtained. In the event that interferences develop, the Owner's Representative's decision will be final as to which Division shall relocate its work, and no additional compensation will be allowed for the moving of piping, ductwork, conduit, or equipment, to clear such interferences. Provide templates, information, and instructions to other divisions to properly locate holes and openings to be cut or provided

1.26 HOIST, RIGGING, TRANSPORTATION AND SCAFFOLDING

A. Provide all scaffolding, staging, cribbing, tackle hoist and rigging necessary for placing all materials and equipment in their proper places in the Project. All temporary work shall be removed from the premises when its use is no longer required.

1.27 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment in its original package to prevent damage or entrance of foreign matter. Perform all handling and shipping in accordance with manufacturer's recommendations. Provide protective coverings during construction.

B. Identify materials and equipment delivered to Site to permit check against approved materials list, reviewed Shop Drawings.

C. Keep all materials clean, dry and free from damaging environments during construction.

D. Cap all openings in piping daily to protect against entry by foreign matter.

E. Protect premises and Work of other Divisions from damage arising out of installation of Work of this Division.

F. Perform Work in manner precluding unnecessary safety and hazard.

G. Protect from loss or damage. Replace lost or damaged materials and equipment with new at no increase in Contract Sum. Protect from damage, water, dust, etc., material, equipment and apparatus provided under this Division, both in storage and installed, until Notice of Completion has been filed. Provide temporary storage facilities for material and equipment. Material, equipment or apparatus damaged because of improper storage or protection will be rejected. Remove from Site and provide new, duplicate material, equipment or apparatus in replacement of that rejected.

H. All stock piled piping shall be placed on dunnage, and protected from weather and from entry of foreign material. All stored materials and equipment shall be carefully inspected prior to installation and replaced with new material or equipment if found to be damaged, corroded, etc.

1.28 GUARANTEE AND 24 HOUR SERVICE

A. Guarantee the Work of this section for one year following the date of Substantial Completion or successful system performance whichever requires later. The warranty may also commence if a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization of the Owner. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the owner.

B. The guarantee shall repair or replace defective materials, equipment, workmanship and installation that develop within this period, promptly and to the Consultant's satisfaction and correct damage caused in making necessary repairs and replacements under guarantee within Contract Price.

C. In addition to guarantee requirements of Division 1 and of Paragraph A above, obtain written equipment and material warranties offered in manufacturer's published data without exclusion or limitation, in Owner's name.

D. Replace material and equipment that require excessive service during guarantee period as defined and as directed by the Consultant.

E. Provide 24 hour service beginning on the date of substantial completion and lasting until the termination of guarantee period. Service shall be at no cost to Owner. Service can be provided by this Contractor or a separate service organization. Choice of service organization shall be subject to the Consultant and Owner approval. Submit name and phone number that will be answered on a 24 hour basis each day of the week, for the duration of the service.

F. Submit copies of equipment and material warranties to Consultants before final payment.

G. At end of guarantee period, transfer manufacturer's equipment and warranties still in force to Owner.

H. This paragraph shall not be interpreted to limit Owner's rights under applicable codes and laws under this Contract.

I. Part 2 Paragraphs of the Specification sections may specify warranty requirements that may exceed those of this Paragraph.

J. Use of systems provided under this Section for temporary services and facilities shall not constitute Final Acceptance of work nor beneficial use by Owner, and shall not institute guarantee period.

K. Provide manufacturer's engineering and technical staff at site to analyze and rectify problems that develop during guarantee period immediately. If problems cannot be rectified immediately to Owner's satisfaction, advise the Consultant in writing, describe efforts to rectify situation, and provide analysis of cause of problem. Consultants will suggest course of action.

PART 2 PRODUCTS

2.1 GENERAL

A. Equipment and materials shall be as described in the respective Sections of Division 21, 22, 23 and Division 26 and as shown.

2.2 MATERIALS

A. Equipment specified by manufacturer's number shall include all accessories, controls, etc., listed in catalog as standard with equipment. Furnish optional or additional accessories as specified. And or/as required to provide a fully operational installation.

B. Equipment, material damaged during transportation, installation, and operation is considered as totally damaged. Replace with new. Payment for this equipment shall not be approved. Variance from this permitted only with written acceptance.

C. All items of materials in each category of equipment shall be of one manufacturer.

D. Material and Equipment-General Requirements:

1. All equipment and components shall be New.
2. Testing agency labeled or with other identification wherever standards have been established.
3. Owner's Representative reserves right to reject items not in accordance with Specification either before or after installation.
4. Comprised to render complete and operable systems; provide additional items needed to complete installation to realized design.
5. Compatible with space allocated. Modifications necessary to adjust items to space limitations at Contractor's expense.
6. Installed fully operating and without objectionable noise or vibration.

PART 3 EXECUTION

3.1 COMMISSIONING OF EQUIPMENT AND SYSTEMS

A. General

1. Completion of startup and commissioning shall be accomplished as a prerequisite for substantial completion and shall be completed for each phase of construction.

2. Operate and maintain systems and equipment until final acceptance by Owner.
3. All guarantees and warranties shall not begin until final acceptance of the systems and equipment by the Owner. Acceptance requires, at a minimum complete systems and commissioning.
4. The Owner maintains the right to have access to the entire project site to develop his own operational procedures.

B. Comprehensive Work Plan and Reporting

1. Provide detailed, methodical, scheduled, start up and commissioning procedures and execution of same and every system and piece of equipment provided.
2. Attend start up and commissioning meetings on a regular basis, as directed by the General Contractor or Construction Manager.
3. Develop and provide a written work plan with detailed procedures for this work and submit, using shop drawing submittal procedure, within 6 weeks of the contract award. The work plan shall include provisions for an integrated start up plan and schedule. The plan and schedule shall identify tasks, start and completion dates, critical path items, interface requirements with other trades and major equipment start up, as minimum requirements of the plan. The plan and schedule shall clearly identify work in each construction phase, as well.
4. The purpose of this work plan is to provide for smooth, quick, and efficient start up and commissioning of systems and equipment and for a smooth transition to turn the complete, correctly operating building over to the Owner, at each phase of construction.
5. The Owner and the Consultant will have input to and be part of approval process for startup and commissioning plan.
6. Develop and submit for approval a specific start up, check out and sign off form for every piece of major equipment.
7. Develop and submit for approval a specific start up, check out and sign off form for every piece of major system.
8. Systems shall be operated under actual or simulated full load conditions. Identify the operating conditions in the work plan.
9. Work plan shall incorporate the below specified "Demonstration of Successful Operation"
10. The Consultant/Owner may check the completed and commissioned installation either sequentially as different parts are completed, and/or when the entire installation is complete, at sole option of the Consultant/Owner.
11. Each contractor shall arrange that an officer of his contracting company shall certify that each and every system has been tested. At the conclusion of the tests, this contractor shall submit a letter and enclosed commissioning forms signed by the officer stating:

    a. That he/she is the officer of the company.
    b. That he/she certifies that the specified testing of the systems has been performed by the company (give the name and dates of system testing).
    c. The results of testing as compared to specified performance, listing the name, title, and company affiliation of all those witnessing and performing these tests.

C. Commissioning

1. Commission equipment and systems in accordance with the approved work plan, completing the startup, check out and sign off forms for each piece of equipment and each system.
2. Provide qualified personnel, equipment, apparatus and services for startup and testing of equipment and systems, to obtain the performance shown in schedules, as specified or on commissioning forms, and as required by codes, standards, regulations and authorities having jurisdiction including Municipal Inspectors, Owners and Consultants.

3. Start up and testing procedures as may be outlined in various mechanical and electrical sections of the specifications are the minimum effort required for the project. Contractor shall use any additional procedures he feels will be necessary to properly start up and test the systems and equipment actually installed on the job at no additional cost to the Owner.
4. Provide capacity and performance of equipment by field testing. Install thermowells and gauge connections and, at no additional cost to Owner, equipment and instruments required for testing.
5. Qualified representative of equipment manufacturer shall be present at test.
6. For each piece of equipment, copy nameplate data and include with the letter and start up, check out and sign off forms referred to above.
7. Do not cover or conceal work before testing and inspection and obtaining approval.
8. Leaks, damage and defects discovered or resulting from startup and testing shall be repaired or replaced by this contract to like-new condition with acceptable materials. Tests shall be continued until system operates without adjustments or repairs.

D. Demonstration of Successful Operation: After all components and every system has been completely commissioned, provide a two week, 24 hour per day fully functional automatic operation period of all systems simultaneously. This shall be successfully concluded before systems are accepted by the Owner.

3.2 SPECIAL RESPONSIBILITIES:

A. Cooperate and coordinate with work of other Sections in executing work of this Section.

1. Perform work such that progress of entire project including work of other Sections shall not be interfered with or delayed.
2. Provide information as requested on items furnished under this Section which shall be installed under other Sections.
3. Obtain detailed installation information from manufacturers of equipment provided under this section.
4. Obtain final roughing dimensions or other information needed for complete installation of items furnished under other Sections or by Owner.
5. Keep fully informed as to shape, size and position of openings required for material or equipment to be provided under this and other Sections. Give full information so that openings required by work of this Section may be coordinated with other work and other openings and may be provided for in advance. In case of failure to provide sufficient information on proper time, provide cutting and patching or have same done, at own expense and to full satisfaction of Consultants.
6. Provide information as requested as to sizes, number and locations of pads necessary for floor mounted equipment provided under this Section.
7. Notify Consultants of location and extent of existing piping, conduit, ductwork and equipment that interferes with new construction. In coordination with and with approval of Consultants, relocate piping, ductwork and equipment to permit new work to be provided as required by Contract Documents. Remove non-functioning and abandoned piping, ductwork and equipment as directed by Consultants. Dispose of or store items as requested by Consultants.

B. Installation Only Items

1. Where this contractor is required to install items which it does not purchase, it shall coordinate delivery and be responsible for their unloading from delivery vehicles and for their safe handling and field storage up to time of installation. This trade shall be responsible for:

a. Any necessary field assembly and internal connections, as well as mounting in place of the items, including the purchase and installation of all dunnage supporting members and fastenings necessary to adapt to Consultant's and structural conditions.
b. Their connection to building systems including the purchase and installation of all terminating fittings necessary to adapt and connect them to the building systems.

2. This contractor shall carefully examine such items upon delivery. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of work of this contractor will be considered only if presented in writing within one week of their date of delivery. Unless such claims have been submitted this contractor shall be fully responsible for the complete reconditioning or replacement of the damaged items.

C. Maintenance of equipment and systems: Maintain equipment and systems until Final Acceptance. Ensure adequate protection of equipment and material during delivery, storage, installation and shutdown and during delays pending final test of systems and equipment because of seasonal conditions.

D. Use of premises: Use of premises shall be restricted as directed by the Consultant and as required below:

1. Remove and dispose of dirt and debris, and keep premises clean. During progress of work, remove equipment and unused material. Put building and premises in neat and clean condition, and do cleaning and washing required to provide acceptable appearance and operation of equipment, to satisfaction of the Consultant.
2. Store materials in a manner that will maintain an orderly clean appearance. If stored on-site in open or unprotected areas, all equipment and material shall be kept off the ground by means of pallets of racks and covered with tarpaulins.
3. Do not interfere with function of existing sewers and water and gas mains, electrical or mechanical systems and services. Extreme care shall be observed to prevent debris from entering pipe, ductwork and equipment. Confer with the Consultant as to the disruption of services or other utilities due to testing, connection of new work to existing. Interruption of services shall be performed at time of day or night deemed by Owner to provide minimal interference with normal operation. Obtain Owner's approval of the method proposed for minimizing service interruption.

E. Surveys and Measurements:

1. Base measurements, both horizontal and vertical, on reference points established by Contractor and be responsible for correct laying out of work.
2. In event of discrepancy between actual measurements and those indicated, notify the Consultant in writing and do not proceed with work until written instructions have been issued by the Consultant.

F. Fireproofing:

1. Clip, hangers, clamps, supports and other attachments to surfaces to be fireproofed shall be installed, insofar as possible prior to start of spray fiber work.
2. Conduit and other items which would interfere with proper application of fireproofing shall be installed after completion of spray fiber work.

3. Patching and repairing of fireproofing due to cutting or damaging to fireproofing during course of work specified under this section shall be shall be performed by installer of fireproofing and paid for by the trade responsible for damage and shall not constitute grounds for an extra to Owner.

G. Temporary Utilities:

1. Refer to Division 1 regarding requirements.
2. Furnish temporary equipment, and piping as needed during the construction phase. Remove temporary items after use.

3.3 MATERIAL AND WORKMANSHIP

A. Work shall be neat and rectilinear. Conduit shall run concealed except in mechanical rooms and areas where no hung ceiling exists. Install material and equipment to comply with manufacturers. Recommended Requirements. Rough Work will be rejected. Work shall be properly and effectively protected, and conduit openings shall be temporarily closed to prevent obstruction and damage before completion.

B. Except as specified otherwise, material and equipment shall be new. Provide supplies, appliances and connections necessary for complete and operational installation. Provide components required or recommended by OSHA and applicable NFPA documents.

C. Finish of materials, components and equipment shall be as approved by the Consultant and shall be resistant to corrosion and weather as necessary.

D. Owner will not be responsible for material and equipment before testing, commissioning, and acceptance.

3.4 CONTINUITY OF SERVICES

A. Do not interrupt existing services without Owner's approval.

B. Schedule interruptions in advance, according to Owner's instructions. Submit, in writing, with request for interruption, methods proposed to minimize length of interruption.

C. Interruptions shall be scheduled at such times of day and work so that they have minimal impact to Owner's operations.

D. Subcontractor shall coordinate any shutdowns of existing systems as follows:

1. Give proper notice to Owner when making shutdowns; a minimum of fourteen full days are required.
2. Minimize shutdowns of any system.
3. Provide temporary services where required and perform shutdown and tie-ins at a time convenient to Owner.
4. Subcontractor shall be responsible for completing and filing Owner's shutdown notice questionnaire.
5. Perform required survey and inspection work required by the notice for shutdown.

E. Include premium time work associated with interruption of services and/or shutdown as necessary to avoid disruption to Owner's operations.

3.5 ANCHORS AND INSERTS:

A. Inserts shall be iron or steel of type to receive machine bolt head or nut after installation. Insert shall permit adjustment of bolt in one horizontal direction and shall develop strength of bolt when installed in properly cured concrete.

B. Provide anchors as necessary for attachment of equipment support and hangers.

3.6 CORE DRILLING

A. Core drilling is to be avoided.

B. Set sleeves prior to installation of structure for passage of conduits, etc.

C. Where core drilling is unavoidable, or required by renovation projects, locate all required openings prior to coring and submit to the Consultant for review.

D. Coordinate openings with General Contractor/Construction Manager and all other trades.

E. Core drilling is to be provided by the Contractor for General Construction and not by the M/E subcontractors.

F. Do not disturb existing systems.

G. Thoroughly investigate existing conditions in vicinity of required opening prior to coring.

3.7 CUTTING AND PATCHING:

A. Complete cutting and patching in accordance with Division 1, Cutting and Patching Article, and as follows.

B. Provide all sleeves, core drilling, carpentry, cutting and patching required for proper installation of material and equipment specified in this Division.

C. Do not cut or drill structural members without written approval of Owner's Representative and structural engineer.

D. No cutting or patching should be done without first receiving the Consultant's and Structural Engineer's written approval.

E. Any damage caused by cutting and patching shall be restored to the original condition as required by the Consultant.

3.8 VIBRATION CONTROL:

A. Coordinate with Division 1.

B. Design criteria for all the Work of Division 22 shall be as specified in 220548.

3.9 WATERPROOF CONSTRUCTION:

A. Maintain waterproof integrity of penetrations of materials intended to be waterproof. Provide flashing at exterior wall and roof penetrations. Caulk watertight penetrations of foundation walls and floors. Provide membrane clamps at penetrations of waterproof membranes.

B. Provide galvanized sheet metal weather protection canopies, hoods or enclosures over all out-of-doors equipment, the operation or maintenance of which would be impaired by rainwater. This requirement applies to damper operators and bearing, damper motors, controls, and instruments. See other paragraphs in this Division for application of this requirement to panels, motors, and devices.

3.10 RESTORATION OF DAMAGE:

A. Repair or replace, as directed by the Consultant and/or Owner's Representative, materials and parts of premises which become damaged as result of installation of Work of this Division. Remove replaced parts from premises.

3.11 ROOF OPENINGS AND CURBS

A. Roof openings where required shall be coordinated with the other affected trades and all flashing and patching shall be as per details indicated on the Consultant's plans.

3.12 TOOLS AND EQUIPMENT

A. Furnish all tools and equipment necessary for the proper installation, protection and upkeep of the Work.

3.13 ADJUSTMENTS

A. Preliminary Operation:

1. Operate any portion of installation for Owner's convenience if so requested by Construction Manager. Such operation does not constitute acceptance of Work as complete. Cost of utilities, such as gas and electrical power, will be borne by Owner if Owner requests operation.

B. Start-up Service:

1. Prior to startup, ensure that systems are ready for their intended use.

C. Start and operate all systems. Provide services of factory trained technicians for startup of major equipment and systems.

D. Adjusting:

1. Adjust all equipment and system components as shown or as otherwise required to result in intended system operation.

2. Thereafter, as a result of system operation or as directed by Owner's Representative, make readjustments as necessary to refine performance and to effect complete system "tune-up".
3. After completion of testing and adjustment, operate the different systems and equipment under normal working conditions for 72 hours continuously and show specified performance.
4. If, in the opinion of the Consultant, performance of equipment or systems is not in accordance with specifications or submitted data, alter or replace equipment at no increase in Contract Sum. The Contractor, at his option, may order tests from an independent approved laboratory to prove compliance. All such tests shall be at no increase in Contract Sum. Repeat process as often as required. If the reason for unsatisfactory operation is design errors all additional cost for corrective measures will be reimbursed to the contractor.
5. At completion of Work, provide written certification that all systems are functioning properly without defects.

E. Noise:

1. Cooperate in reducing any objectionable noise or vibration caused by electrical systems to the extent of adjustments to specified and installed equipment and appurtenances.
2. Cooperate in adjustment of mechanical systems and terminal devices, as directed by Owner's Representative, to obtain specified acoustic properties.
3. Completely correct noise problems caused by failure to make installation in accordance with Contract Documents, including labor and materials required as a result of such failure, at no increase in Contract Sum. Includes refinish walls, floors etc.

3.14 INSTALLATION OF EQUIPMENT

A. Use printed descriptions, specifications and recommendations of manufacturers as a guide for installation of Work.

B. Assemble equipment required to be field assembled under the direct supervision of the manufacturers' agent. Prior to the final acceptance submit letters from the manufacturers that this has been done.

C. Avoid interference with structure and with work of other trades, preserving adequate headroom and clearing doors and passageways, to the satisfaction of the Consultant and in accordance with code requirements. Installation shall permit clearance for access to equipment for repair, servicing and replacement.

D. Install equipment so as to properly distribute equipment loads on building structural members provided for equipment support under other Sections. Roof mounted equipment shall be installed and supported on structural steel provided under other Sections.

E. Provide suspended platforms, strap hangers, brackets, shelves, stands or legs as necessary for floor, wall of ceiling mounting of equipment as required.

F. Provide steel supports and hardware for proper installation of hangers, anchors, guides, etc.

G. Provide cuts, weights, and other pertinent data required for proper coordination of equipment support provisions and installations.

H. Structural steel and hardware shall conform to Standard specifications of ASTM; use of steel and hardware shall conform to requirements of Section V of Code of Practice of American Institute of Steel Construction.

I. Verify site conditions and dimensions of equipment to ensure access for proper installation of equipment without disassembly, which will void warrantee. Report in writing to the Consultant, prior to purchase or shipment of equipment involved, on conditions which may prevent proper installation.

3.15 PAINTING

A. Equipment installed shall have shop coat of non-lead paint. Hangers and supports shall have one coat of non-lead primer. Finish painting, including painting of various conduit or wire way systems, shall be done under other Sections.

B. Paint all outside exposed equipment and equipment supports with two coats of weather resistant enamel.

C. Properly prepare Work under this Division to be finish painted under Division 9.

D. Refer to standard paint colors for all Plumbing equipment inside the Building.

3.16 SELECTIVE DEMOLITION

A. Refer to all drawings for general description of areas requiring demolition.

B. Refer to General Contractor's/Construction Manager's Instructions for all existing equipment and materials that shall remain the property of the Owner.

C. Items of value which are not directed to be returned to the Owner shall become the property of the Contractor. Storage or sale of items on the project site is prohibited.

D. Protection: Ensure the safe passage of persons in and around building during demolition. Prevent injury to persons and damage to property. Provide adequate shoring and bracing to prevent collapse. Immediately repair damaged property to the condition before being damaged. Take effective measures to prevent windblown dust.

E. Utilities: Maintain all utilities except those requiring removal or relocation. Keep utilities in service and protect from damage. Do not interrupt utilities serving used areas without first obtaining permission from the utility company and the Owner. Provide temporary services as required.

3.17 JOBSITE SAFETY

A. Neither the professional activities of the Engineer, nor the presence of the Engineer or his or her employees and sub-consultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Engineer and his or her personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Engineer and the Engineer's consultants shall be indemnified and shall be made additional insured's under the Contractor's general liability insurance policy.

3.18 FINAL JOBSITE OBSERVATION

A. As the work nears completion, the Contractor is to review the requirements of the Contract Documents, inspect the work and inform all parties involved of the work to be corrected or completed before the project can be deemed substantially complete.

B. When the Project is substantially complete, In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation. Notify the Owner's Representative in writing of this fact, listing any items of Work remaining incomplete, the reason therefore, and the anticipated date that all remaining work will be completed. The Contractor shall inform the certification that the project is complete and ready for a final punch; the Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.

C. It is understood that if the Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Engineers additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

D. The Contractor shall carry out their own final inspection and satisfy the Work.

E. The Owner's Representative reserves the right to cancel and reschedule the inspection in the event considerable more work remains to be completed or corrected than indicated in the written request for inspection.

F. All items not completed or found not complying with drawings or specifications by the Owner's Representative will be identified in their inspection report.

G. Correct all items on inspection report. Make the correction and initial and date each item on the report after corrections have been completed.

H. Include the fee for all local inspections.

3.19 INSTRUCTING THE OWNER'S REPRESENTATIVES

A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.

B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.

C. The Owner has the option to video tape all instructions. Coordinate schedule of instructions to facilitate this recording.

D. The instructions shall include:

1. Maintenance of equipment.
2. Start-up procedures for all major equipment.
3. Description of emergency system operation.

3.20 PROJECT CLOSE-OUT PROCEDURE

A. General

1. The requirements of this section are in addition to and supplement the requirements outlined in Division 1.
2. It shall be each contractor's responsibility to personally hand-deliver all of the required project close-out checklist items and to obtain Owner's authorized representative(s) signed receipt on all items requiring Owner sign-off.

B. Project Close-Out Checklist

1. Review requirements of each section of the specifications and submit for approval to Consultants the sign-off forms which shall become the project close-out checklist. These, at a minimum, shall include the following information shown in attached Project Closeout Checklist Example. The Consultants and/or Owner may incorporate additional specific items to the following checklist which shall become part of project requirements.
2. Close-Out Checklist Example:

PROJECT CLOSE-OUT			
PROJECT:			
DIVISION NO:			
CONTRACTOR:			
ITEM1	DATES		OWNER'S SIGN-OFF
	COMPLETED	RECEIVED BY OWNER	
Permits			
City and County Inspection			
Manufacturer's Warranties			
Factory Startup Reports Submitted			
Copy of Final Shop Drawings			
List and Possession of Spare Parts			
Pressure Tests			
Equipment Tests Required by Specs			
O&M Manuals			
Record Documents			

Coordination Drawings			
Sanitization Reports			
Commissioning Reports/Letters/Forms			
On Site Training Complete			
Protective Device Settings			
Valve Tags and Charts			
Final ATC Installation Drawings			
Insurance Underwriters Approvals			
Final Punch List (Initialed by contractor that items are complete)			
Building Certificate of Occupancy			
24 Hr. Phone No. for Service During Guarantee Period.			
1 Provide separate line item for each specified item (do not group items).			

READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

In order to prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

3. 1. Penetrations fire sealed and labeled in accordance with specifications.
4. 2. All pumps operating and balanced.
5. 3. All plumbing fixtures installed and caulked.
6. 4. Pipe insulation complete, pipes labeled and valves tagged.
7. 5. Factory startup reports for water softener and hot water systems
8. 6. Factory startup reports for pressure boosting system
9. 7. Factory startup reports for grey water treatment system
10. 8. Factory startup reports for black water treatment system

Accepted by:

Contractor _____

By _____ Date _____

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Engineer so that the final observation can be scheduled.

It is understood that if the Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

END OF SECTION 220000

SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

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:

1. Sleeves.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 PRODUCTS

2.1 SLEEVES

A. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop collar.

B. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized, with plain ends and integral welded waterstop collar.

C. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).

B. Description:

1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

2. Designed to form a hydrostatic seal of 20 psig minimum.
3. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
4. Pressure Plates: Carbon steel.
5. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, ASTM B 633 of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).

B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.

C. Plastic or rubber waterstop collar with center opening to match piping OD.

PART 3 EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

3. Using , seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Use to seal the space around outside of sleeve-seal fittings.

3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:

   a. Piping Smaller Than NPS 6: Sleeve-seal fittings.

2. Exterior Concrete Walls below Grade:

   a. Piping Smaller Than NPS 6: Steel pipe sleeves with sleeve-seal system.

      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

   b. Piping NPS 6 and Larger: Steel pipe sleeves with sleeve-seal system.

      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:

a. Piping Smaller Than NPS 6: Steel pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

b. Piping NPS 6 and Larger: Cast-iron pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade:

a. Piping Smaller Than NPS 6: Steel pipe sleeves .

5. Interior Partitions:

a. Piping Smaller Than NPS 6: Steel pipe sleeves.

END OF SECTION 220517

SECTION 220518 - ESCUTCHEONS FOR PLUMBING PIPING

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:

1. Escutcheons.
2. Floor plates.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Steel Type: With finish and setscrew fastener.

B. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed hinge; and spring-clip fasteners.

2.2 FLOOR PLATES

A. Split Floor Plates: Cast brass with concealed hinge.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
b. Chrome-Plated Piping: One-piece with polished, chrome-plated finish.
c. Insulated Piping: One-piece steel with finish.
d. Insulated Piping: One-piece stainless steel with polished stainless-steel finish.
e. Insulated Piping: One-piece cast brass with finish.
f. Insulated Piping: One-piece stamped steel [or split-plate, stamped steel with concealed hinge] [or split-plate, stamped steel with exposed-rivet hinge] with polished, chrome-plated finish.
g. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece steel with finish.
h. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece stainless steel with polished stainless-steel finish.
i. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece cast brass with finish.
j. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece stamped steel [or split-plate, stamped steel with concealed hinge] [or split-plate, stamped steel with exposed-rivet hinge] with polished, chrome-plated finish.
k. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece steel with finish.
l. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece stainless steel with polished stainless-steel finish.
m. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece cast brass with finish.
n. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece stamped steel [or split-plate, stamped steel with concealed hinge] [or split-plate, stamped steel with exposed-rivet hinge] with polished, chrome-plated finish.
o. Bare Piping in Unfinished Service Spaces: One-piece steel with polished, chrome-plated finish.
p. Bare Piping in Unfinished Service Spaces: One-piece cast brass with finish.
q. Bare Piping in Unfinished Service Spaces: One-piece stamped steel [or split-plate, stamped steel with concealed hinge] [or split-plate, stamped steel with exposed-rivet hinge] with polished, chrome-plated finish.
r. Bare Piping in Equipment Rooms: One-piece steel with polished, chrome-plated finish.
s. Bare Piping in Equipment Rooms: One-piece cast brass with finish.
t. Bare Piping in Equipment Rooms: One-piece stamped steel [or split-plate, stamped steel with concealed hinge] [or split-plate, stamped steel with exposed-rivet hinge] with polished, chrome-plated finish.

2. Bare Piping in Equipment Rooms: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping : One-piece, floor plate.

3.2 FIELD QUALITY CONTROL

A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION 220518

SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING

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:

1. Bimetallic-actuated thermometers.
2. Dial-type pressure gages.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

A. Standard: ASME B40.200.

B. Case: Liquid-filled type(s); stainless steel with 5-inch nominal diameter.

C. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F.

D. Connector Type(s): Union joint, rigid, bottom, with unified-inch screw threads.

E. Connector Size: 1/2 inch, with ASME B1.1 screw threads.

F. Stem: 0.25 or 0.375 inch in diameter; stainless steel.

G. Window: Plain glass.

H. Ring: Stainless steel.

I. Element: Bimetal coil.

J. Pointer: Dark-colored metal.

K. Accuracy: Plus or minus 1 percent of scale range.

2.2 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Standard: ASME B40.100.
2. Case: Sealed type(s); cast aluminum or drawn steel; 6-inch nominal diameter.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

H. Install remote-mounted pressure gages on panel.

I. Install valve and snubber in piping for each pressure gage for fluids.

J. Install test plugs in piping tees.

K. Install thermometers in the following locations:

1. Inlet and outlet of each water heater.

L. Install pressure gages in the following locations:

1. Building water service entrance into building.

2. Inlet and outlet of each pressure-reducing valve.
3. Suction and discharge of each domestic water pump.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

A. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each domestic water heater shall be one of the following:

1. Liquid-filled, bimetallic-actuated type.
2. Direct -mounted, -case, vapor-actuated type.
3. case, compact -style, liquid-in-glass type.
4. Direct -mounted, light-activated type.
5. Test plug with self-sealing rubber inserts.

B. Thermometers at inlets and outlets of each domestic water heat exchanger shall be[one of] the following:

1. Liquid-filled, bimetallic-actuated type.
2. [Direct] [Remote]-mounted, -case, vapor-actuated type.
3. case, [compact] [industrial]-style, liquid-in-glass type.
4. [Direct] [Remote]-mounted, light-activated type.
5. Test plug with self-sealing rubber inserts.

C. Thermometers at inlet and outlet of each domestic hot-water storage tank shall be one of the following:

1. Liquid-filled, bimetallic-actuated type.
2. Direct -mounted, -case, vapor-actuated type.
3. case, compact -style, liquid-in-glass type.
4. Direct -mounted, light-activated type.

D. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F.

B. Scale Range for Domestic Hot-Water Piping: 20 to 240 deg F.

3.6 PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each water service into building shall be one of the following:

1. Liquid-filled, direct -mounted, metal case.
2. Test plug with self-sealing rubber inserts.

B. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be one of the following:

1. Liquid-filled, direct -mounted, metal case.
2. Test plug with self-sealing rubber inserts.

C. Pressure gages at suction and discharge of each domestic water pump shall be[one of] the following:

1. Liquid-filled, direct -mounted, metal case.
2. Test plug with self-sealing rubber inserts.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping: 0 to 100 psi.

B. Scale Range for Domestic Water Piping: 0 to 160 psi.

END OF SECTION 220519

SECTION 220523.12 - BALL VALVES FOR PLUMBING PIPING

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:

1. Brass ball valves.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1. Certification that products comply with NSF 61and NSF 372.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, and soldered ends.
3. Set ball valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges on steel valves.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
5. ASME B16.18 for solder-joint connections.
6. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.

D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 4 and larger.
2. Handlever: For quarter-turn valves smaller than NPS 4.

H. Valves in Insulated Piping:

1. Include 2-inch stem extensions.
2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

2.2 BRASS BALL VALVES

A. Brass Ball Valves, Two-Piece with Full Port and Brass Trim, Threaded or Soldered Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Flow Controls; Conbraco Industries, Inc.
b. Milwaukee Valve Company.
c. NIBCO INC.
d. WATTS.

2. Description:

a. Standard: MSS SP-110 or MSS SP-145.
b. CWP Rating: 600 psig.
c. Body Design: Two piece.
d. Body Material: Forged brass.
e. Ends: Threaded and soldered.
f. Seats: PTFE.
g. Stem: Brass.
h. Ball: Chrome-plated brass.
i. Port: Full.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.END OF SECTION 220523.12

SECTION 220523.13 - BUTTERFLY VALVES FOR PLUMBING PIPING

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:

1. Iron, single-flange butterfly valves.
2. Chainwheels.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene-diene terpolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set butterfly valves closed or slightly open.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.1 for flanges on iron valves.
2. ASME B16.5 for flanges on steel valves.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B31.9 for building service piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

D. NSF Compliance: NSF 61 Annex G and NSF 372 for valve materials for potable-water service.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Actuator Types:

1. Gear Actuator: For valves NPS 8and larger.
2. Handlever: For valves NPS 6 and smaller.
3. Chainwheel: Device for attachment to gear, handlever, or stem; of size and with chain for mounting height, according to "Valve Installation" Article.

H. Valves in Insulated Piping: With 2-inch stem extensions.

2.2 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. Iron, Single-Flange Butterfly Valves with Stainless-Steel Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; Conbraco Industries, Inc.
b. Milwaukee Valve Company.
c. NIBCO INC.
d. WATTS.

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating, NPS 12and Smaller: 200 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Stainless steel.

2.3 CHAINWHEELS

A. Description: Valve actuation assembly with sprocket rim, chain guides, chain.

1. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine mating flange faces for damage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

D. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for butterfly valves [NPS 4] <Insert size> and larger and more than [96 inches] <Insert dimension> above floor. Extend chains to [60 inches] <Insert dimension> above finished floor.

F. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION 220523.13

SECTION 220523.14 - CHECK VALVES FOR PLUMBING PIPING

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:

1. Bronze swing check valves.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene-diene terpolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1. Certification that products comply with NSF 61[and NSF 372].

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B16.18 for solder joint.
5. ASME B31.9 for building services piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

D. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.

E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

F. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

G. Valve Sizes: Same as upstream piping unless otherwise indicated.

H. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE SWING CHECK VALVES

A. Bronze Swing Check Valves with Bronze Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Flow Controls; Conbraco Industries, Inc.
b. Milwaukee Valve Company.
c. NIBCO INC.
d. WATTS.

2. Description:

a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded or soldered. See valve schedule articles.
f. Disc: Bronze.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Check Valves: Install check valves for proper direction of flow.

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Check Valves: In horizontal or vertical position, between flanges.

F. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Pump-Discharge Check Valves:

a. NPS 2 and Smaller: Bronze swing check valves with [bronze] [or] [nonmetallic] disc.
b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or spring; or iron, center-guided, [metal-seat] [or] [resilient-seat] check valves.
c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.

B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

C. End Connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded or soldered or press-ends.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged or threaded.
3. For Copper Tubing, NPS 5 and Larger: Flanged.

END OF SECTION 220523.14

SECTION 220523.15 - GATE VALVES FOR PLUMBING PIPING

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:

1. Iron gate valves.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. NRS: Nonrising stem.

C. OS&Y: Outside screw and yoke.

D. RS: Rising stem.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1. Certification that products comply with NSF 61 and NSF 372.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set gate valves closed to prevent rattling.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B16.18 for solder joint.
5. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 and NSP 372 for valve materials for potable-water service.

D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. RS Valves in Insulated Piping: With 2-inch stem extensions.

H. Valve Bypass and Drain Connections: MSS SP-45.

2.2 IRON GATE VALVES

A. Iron Gate Valves, NRS, Class 150:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Flow Controls; Conbraco Industries, Inc.
b. Milwaukee Valve Company.
c. NIBCO INC.
d. Red White Valve Corp.
e. WATTS.

2. Description:

a. Standard: MSS SP-70, Type I.
b. CWP Rating: 200 psig.
c. Body Material: Gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Disc: Solid wedge.
g. Packing and Gasket: Asbestos free.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for gate valves [NPS 4] <Insert size> and larger and more than [96 inches] <Insert dimension> above floor. Extend chains to [60 inches] <Insert dimension> above finished floor.

F. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. Use gate valves for shutoff service only.

B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

C. For Grooved-End Copper Tubing: Valve ends may be grooved.

END OF SECTION 220523.15

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

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:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Equipment supports.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers.
2. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Include design calculations for designing trapeze hangers.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
3. Nonmetallic Coatings: Plastic coated or epoxy powder coated.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel stainless steel.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon-steel shapes, with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-carbon-steel shapes.

2.5 MATERIALS

A. Aluminum: ASTM B 221.

B. Carbon Steel: ASTM A 1011/A 1011M.

C. Structural Steel: ASTM A 36/A 36M carbon-steel plates, shapes, and bars; black and galvanized.

D. Stainless Steel: ASTM A 240/A 240M.

E. Grout: ASTM C 1107/C 1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 EXECUTION

3.1 APPLICATION

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

D. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

E. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

F. Install lateral bracing with pipe hangers and supports to prevent swaying.

G. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, [NPS 2-1/2] <Insert size> and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms, and install reinforcing bars through openings at top of inserts.

H. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

I. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

J. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating Below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39 protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    b. NPS 4: 12 inches long and 0.06 inch thick.
    c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
    d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
    e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment, and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and 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 welding flux immediately.
4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

A. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded, shop-painted areas on miscellaneous metal are specified in Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A 780/A 780M.

3.7 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.

G. Use copper-plated pipe hangers and stainless-steel attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal hanger-shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction occurs.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction occurs.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction occurs but vertical adjustment is unnecessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction occurs and vertical adjustment is unnecessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation, in addition to expansion and contraction, is required.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment of up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11 split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

P. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

R. Use [powder-actuated fasteners] [or] [mechanical-expansion anchors] instead of building attachments where required in concrete construction.

S. Use pipe-positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 220529

SECTION 220533 - HEAT TRACING FOR PLUMBING PIPING

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 plumbing piping heat tracing for freeze prevention, domestic hot-water-temperature maintenance, and snow and ice melting on roofs and in gutters and downspouts with the following electric heating cables:

1. Self-regulating, parallel resistance.

B. Related Requirements:

1. Section 230533 "Heat Tracing for HVAC Piping."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

B. Shop Drawings: For electric heating cable.
1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

PART 2 PRODUCTS

2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

B. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:

1. Chromalox.
2. Raychem; a brand of Tyco Thermal Controls LLC.

C. Comply with IEEE 515.1.

D. Heating Element: Pair of parallel No. 16 AWG, nickel-coated, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

E. Electrical Insulating Jacket: Flame-retardant polyolefin.

F. Cable Cover: Stainless-steel braid and polyolefin outer jacket with ultraviolet inhibitor.

G. Maximum Operating Temperature (Power On): 150 deg F.

H. Maximum Exposure Temperature (Power Off): 185 deg F.

I. 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.

2.2 CONTROLS

A. Provide BACnet interface for BMS monitoring

B. Pipe-Mounted Thermostats for Freeze Protection:
1. Remote bulb unit with adjustable temperature range from 30 to 50 deg F.
2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
3. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.
4. Corrosion-resistant, waterproof control enclosure.

2.3 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Labels: Refer to Section 220553 "Identification for Plumbing Piping and Equipment."

C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.
1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install electric heating cable across expansion, construction, and control joints according to manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.

B. Electric Heating-Cable Installation for Freeze Protection for Piping:
   1. Install electric heating cables after piping has been tested and before insulation is installed.
   2. Install electric heating cables according to IEEE 515.1.
   3. Install insulation over piping with electric cables according to Section 220719 "Plumbing Piping Insulation."
   4. Install warning tape on piping insulation where piping is equipped with electric heating cables.

C. Set field-adjustable switches and circuit-breaker trip ranges.

3.3 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[with the assistance of a factory-authorized service representative]:
   1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
   2. Test cables for electrical continuity and insulation integrity before energizing.

3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

D. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

E. Cables will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.5 PROTECTION

A. Protect installed heating cables, including nonheating leads, from damage during construction.

B. Remove and replace damaged heat-tracing cables.

END OF SECTION 220533

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

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:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Valve tags.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

C. Valve numbering scheme.

D. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Letter Color: Black.
3. Background Color: White.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
6. Fasteners: Stainless-steel rivets.

7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Red.

C. Background Color: White.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

G. Fasteners: Stainless-steel rivets.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.

2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.4 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass beaded chain.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. Piping Color Coding: Painting of piping is specified in [Section 099123 "Interior Painting."] [Section 099600 "High-Performance Coatings."]

B. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of [50 feet] <Insert dimension> along each run. Reduce intervals to [25 feet] <Insert dimension> in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

D. Pipe Label Color Schedule:

1. Domestic Water Piping

a. Background: Safety green.
b. Letter Colors: White.

2. Sanitary Waste Piping:

a. Background Color: Safety purple.
b. Letter Color: White.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

a. Cold Water: 2 inches, round.
b. Hot Water: 2 inches, round.

2. Valve-Tag Colors:

a. Cold Water: Safety green.
b. Hot Water: Safety green.

3. Letter Colors:

a. Cold Water: White.
b. Hot Water: White.

END OF SECTION 220553

SECTION 220719 - PLUMBING PIPING INSULATION

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 insulating the following plumbing piping services:

1. Domestic cold-water piping.
2. Domestic hot-water piping.
3. Domestic recirculating hot-water piping.
4. Domestic chilled-water piping for drinking fountains.
5. Sanitary waste piping exposed to freezing conditions.
6. Storm-water piping exposed to freezing conditions.
7. Roof drains and rainwater leaders.
8. Supplies and drains for handicap-accessible lavatories and sinks.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

1.4 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.5 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.6 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come into contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534/C534M, Type I for tubular materials.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Aeroflex USA, Inc.
b. Armacell LLC.
c. K-Flex USA.

G. Mineral-Fiber, Preformed Pipe: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Johns Manville; a Berkshire Hathaway company.
b. Manson Insulation Inc.

2. Preformed Pipe Insulation: Type I, Grade A, without factory-applied jacket.
3. 850 deg F.
4. Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
5. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range of between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature of between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at 4 inches o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 25 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using [preformed fitting insulation] [or] [mitered fittings] made from same material and density as that of adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with [preformed fitting insulation] [or] [sectional pipe insulation] of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using [preformed fitting insulation] [or] [sectional pipe insulation] of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using [preformed fitting insulation] [or] [sectional pipe insulation] of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges, mechanical couplings, and unions, using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as that of pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as that of pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as that of straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as that of straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 INSTALLATION OF POLYOLEFIN INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as that of pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of polyolefin pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.9 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: [Two] <Insert number> finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless steel jackets.

3.10 FIELD QUALITY CONTROL

A. Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to [three] <Insert number> locations of straight pipe, [three] <Insert number> locations of threaded fittings, [three] <Insert number> locations of welded fittings, [two] <Insert number> locations of threaded strainers, [two] <Insert number> locations of welded strainers, [three] <Insert number> locations of threaded valves, and [three] <Insert number> locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.11 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.12 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

1. NPS 1 and Smaller: Insulation shall be one of the following:

a. Flexible Elastomeric: 1/2 inch thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

2. NPS 1-1/4 and Larger: Insulation shall be[one of] the following:

a. Flexible Elastomeric: 1 inch thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: [1 inch] <Insert dimension> thick.

B. Domestic Hot and Recirculated Hot Water:

1. NPS 1-1/4 and Smaller: Insulation shall be one of the following:

a. Flexible Elastomeric: 1 inch thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

2. NPS 1-1/2 and Larger: Insulation shall be[one of] the following:

a. Flexible Elastomeric: 1 inch thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

C. Domestic Chilled Water (Potable):

1. All Pipe Sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: 1 inch thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

D. Stormwater and Overflow:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: 1 inch thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

E. Roof Drain and Overflow Drain Bodies:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: 1 inch thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

F. Sanitary Waste Piping Where Heat Tracing Is Installed:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inches thick.

G. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: 3/4 inch thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
c. Polyolefin: 3/4 inch thick.

END OF SECTION 220719

SECTION 221116 - DOMESTIC WATER PIPING

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:

1. Copper tube and fittings.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Pipe and tube.
2. Fittings.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

1.5 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of water service.
2. Do not interrupt water service without Owner's written permission.

1.6 WARRANTY

A. Polypropylene Piping (PP-R) Manufacturer's Warranty: Manufacturer agrees to repair or replace PP-R pipe and fittings that fail in materials or workmanship within 10 years from date of Substantial Completion.

1. Warranty is to cover labor and material costs of repairing and/or replacing defective materials and repairing any incidental damage caused by failure of the piping system due to defects in materials or manufacturing.

2. Warranty is to be in effect only upon submission by the Contractor to the manufacturer of valid pressure/leak documentation indicating that the system was tested and passed the manufacturer's pressure/leak test.

PART 2 PRODUCTS

2.1 PIPING MATERIALS

A. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372. Include marking "NSF-pw" on piping.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tube: ASTM B88, Type K.

B. Annealed-Temper Copper Tube: ASTM B88, Type K.

C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.

E. Copper Tube, Pressure-Seal-Joint Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Flow Controls; Conbraco Industries, Inc.
b. Mueller Industries, Inc.
c. NIBCO INC.
d. Viega LLC.

2. Fittings: Cast-brass, cast-bronze, or wrought-copper with EPDM O-ring seal in each end.
3. Minimum 200-psig working-pressure rating at 250 deg F.

PART 3 EXECUTION

3.1 PIPING APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

C. Under-building-slab, domestic water, building-service piping, NPS 3 and smaller, shall be one of the following:

1. Annealed-temper copper tube, ASTM B88, Type L; wrought-copper, solder-joint fittings; and brazed joints.

D. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 and larger, shall be one of the following:

1. Annealed-temper copper tube, ASTM B88, Type L; wrought-copper, solder-joint fittings; and brazed joints.

E. Under-building-slab, domestic water piping, NPS 2 and smaller, shall be[one of] the following:

1. Drawn-temper copper tube, ASTM B88, Type L; wrought-copper, solder-joint fittings; and brazed joints.

F. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:

1. Drawn-temper copper tube, ASTM B88, Type L; wrought-copper, solder-joint fittings; and soldered joints.
2. Drawn-temper copper tube, ASTM B88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

G. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be[one of] the following:

1. Drawn-temper copper tube, ASTM B88, Type L; wrought-copper, solder-joint fittings; and soldered joints.

H. Aboveground, combined domestic water-service and fire-service-main piping, NPS 6 to NPS 12DN 150 to, shall be[one of] the following:

1. Stainless steel Schedule 10 pipe, grooved-joint fittings, and grooved joints.

3.2 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.3 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

D. Install underground copper tube in PE encasement according to ASTM A674 or AWWA C105/A21.5.

E. Install valves according to the following:

1. Section 220523.12 "Ball Valves for Plumbing Piping."

2. Section 220523.13 "Butterfly Valves for Plumbing Piping."
3. Section 220523.14 "Check Valves for Plumbing Piping."
4. Section 220523.15 "Gate Valves for Plumbing Piping."

F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."

G. Install domestic water piping level [with 0.25 percent slope downward toward drain] [without pitch] and plumb.

H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

I. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

J. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

K. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

L. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

M. Install piping to permit valve servicing.

N. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

O. Install piping free of sags and bends.

P. Install fittings for changes in direction and branch connections.

Q. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

R. Install pressure gauges on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gauges in Section 220519 "Meters and Gages for Plumbing Piping."

S. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 221123 "Domestic Water Pumps."

T. Install thermometers on[inlet and] outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."

U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.4 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B828 or CDA's "Copper Tube Handbook."

F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools and procedure recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.

G. Push-on Joints for Copper Tubing: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on-joint fittings by inserting tube to measured depth.

H. Extruded-Tee Connections: Form tee in copper tube according to ASTM F2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

I. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.

J. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints according to AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.

K. Joint Construction for Grooved-End Steel Piping: Make joints according to AWWA C606. [Square cut] [Roll] groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.

L. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

M. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.

N. Joints for PEX Tubing, ASTM: Join according to ASTM F1807 for metal insert and copper crimp ring fittings and ASTM F1960 for cold expansion fittings and reinforcing rings.

O. Joints for PEX Tubing, ASSE: Join according to ASSE 1061 for push-fit fittings.

P. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for hangers, supports, and anchor devices in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

C. Install hangers for copper, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Install vinyl-coated hangers for piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping within [12 inches] <Insert dimension> of each fitting.

F. Support vertical runs of copper to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

G. Support vertical runs of piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.7 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

3.8 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

    a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
    b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

    a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
    b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

        1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.

2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
e. Hydrostatic testing and documentation of test results for polypropylene piping to be in accordance with the manufacturer's instructions and submitted to the manufacturer upon successful completion per warranty requirements.
f. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
g. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.10 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Fill and isolate system according to either of the following:

1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Repeat procedures if biological examination shows contamination.
e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

END OF SECTION 221116

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

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:

1. Backflow preventers.
2. Balancing valves.
3. Water-hammer arresters.
4. Trap-seal primer device.

1.3 DEFINITIONS

A. AMI: Advanced Metering Infrastructure.

B. AMR: Automatic Meter Reading.

C. FKM: A family of fluroelastomer materials defined by ASTM D1418.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.2 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Flow Controls; Conbraco Industries, Inc.
b. WATTS.
c. Zurn Industries, LLC.

2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.

4. Pressure Loss: 8 psig maximum, through middle third of flow range.
5. Body: Bronze stainless steel for NPS 2 and smaller; ductile or cast iron with interior lining that complies with AWWA C550 or that is FDA approved stainless steel for NPS 2-1/2 and larger.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
7. Configuration: Designed for horizontal, straight-through flow.
8. Accessories:

    a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
    b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
    c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

B. Double-Check, Backflow-Prevention Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Apollo Flow Controls; Conbraco Industries, Inc.
    b. WATTS.
    c. Zurn Industries, LLC.

2. Standard: ASSE 1015.
3. Operation: Continuous-pressure applications unless otherwise indicated.
4. Pressure Loss: 5 psig maximum, through middle third of flow range.
5. Body: Bronze stainless steel for NPS 2 and smaller; for NPS 2-1/2 and larger.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
7. Configuration: Designed for horizontal, straight-through flow.
8. Accessories:

    a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
    b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.

2.3 BALANCING VALVES

A. Memory-Stop Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Apollo Flow Controls; Conbraco Industries, Inc.
    b. Milwaukee Valve Company.
    c. NIBCO INC.
    d. Red-White Valve Corp.

2. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
3. Pressure Rating: 400-psig minimum CWP.
4. Size: NPS 2 or smaller.
5. Body: Copper alloy.
6. Port: Standard or full port.
7. Ball: Chrome-plated brass or stainless steel.
8. Seats and Seals: Replaceable.

9. End Connections: Solder joint or threaded.
10. Handle: Vinyl-covered steel with memory-setting device.

2.4 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. AMTROL, Inc.
   b. Jay R. Smith Mfg Co; a division of Morris Group International.
   c. MIFAB, Inc.
   d. Precision Plumbing Products.
   e. Sioux Chief Manufacturing Company, Inc.
   f. WATTS.
   g. Zurn Industries, LLC.

2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Metal bellows Piston Diaphragm.
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.5 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap-Seal Primer Device :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Jay R. Smith Mfg Co; a division of Morris Group International.
   b. MIFAB, Inc.
   c. Precision Plumbing Products.
   d. Sioux Chief Manufacturing Company, Inc.
   e. WATTS.

2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

B. Drainage-Type, Trap-Seal Primer Device:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Jay R. Smith Mfg Co; a division of Morris Group International.
   b. Precision Plumbing Products.
   c. Zurn Industries, LLC.

2. Standard: ASSE 1044, lavatory P-trap with NPS 3/8 minimum, trap makeup connection.
3. Size: NPS 1-1/4 minimum.
4. Material: Chrome-plated, cast brass.

PART 3 EXECUTION

3.1 INSTALLATION OF PIPING SPECIALTIES

A. Backflow Preventers: Install in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
3. Do not install bypass piping around backflow preventers.

B. Water Control Valves: Install with inlet and outlet shutoff valves[and bypass with globe valve]. Install pressure gauges on inlet and outlet.

C. Balancing Valves: Install in locations where they can easily be adjusted. Set at indicated design flow rates.

D. Nonfreeze, Sanitary Yard Hydrants: Set with riser pipe in concrete or pavement. Do not encase canister in concrete.

E. Water-Hammer Arresters: Install in water piping in accordance with PDI-WH 201.

F. Supply-Type, Trap-Seal Primer Device: Install with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

G. Drainage-Type, Trap-Seal Primer Device: Install as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

3.2 PIPING CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

3.4 CONTROL CONNECTIONS

A. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.5 IDENTIFICATION

A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.6 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

D. Adjust each in accordance with manufacturer's written instructions, authorities having jurisdiction and the device's reference standard.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[with the assistance of a factory-authorized service representative].

1. Test each reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 221119

SECTION 221123 - DOMESTIC WATER PUMPS

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:

1. Horizontally mounted, in-line, close-coupled centrifugal pumps.

1.3 DEFINITIONS

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include materials of construction, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water pumps to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. 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.

B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 PRODUCTS

2.1 HORIZONTALLY MOUNTED, IN-LINE, CLOSE-COUPLED CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

1. Armstrong Pumps, Inc.
2. Bell & Gossett; a Xylem brand.
3. TACO Incorporated.

B. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted horizontal.

C. Pump Construction:

1. Casing: Radially split with threaded companion-flange connections for pumps with NPS 2 pipe connections and flanged connections for pumps with NPS 2-1/2 pipe connections.
2. Impeller: Statically and dynamically balanced, closed, and keyed to shaft.
3. Shaft and Shaft Sleeve: Steel shaft with deflector, with copper-alloy shaft sleeve. Include water slinger on shaft between motor and seal.
4. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket.
5. Bearings: Oil-lubricated; bronze-journal or ball type.
6. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.

D. Motor: Single speed, with grease-lubricated ball bearings; and resiliently or rigidly mounted to pump casing.

1. Capacities and Characteristics: See Schedule

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220513 "Common Motor Requirements for Plumbing Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.3 CONTROLS

A. Pressure Switches: Electric, adjustable for control of water-supply pump.

1. Type: Water-immersion pressure sensor, for installation in piping.
2. Enclosure: NEMA 250, Type 4X.
3. Operation of Pump: On or off.
4. Transformer: Provide if required.
5. Power Requirement: 24 V, ac.

B. Thermostats: Electric; adjustable for control of hot-water circulation pump.

1. Type: Water-immersion temperature sensor, for installation in piping.
2. Range: 65 to 200 deg F.
3. Enclosure: NEMA 250, Type 4X.
4. Operation of Pump: On or off.
5. Transformer: Provide if required.
6. Power Requirement: 24 V, ac.
7. Settings: Start pump at 105 deg F and stop pump at 120 deg F .

C. Timers: Electric, for control of hot-water circulation pump.

1. Type: Programmable, seven-day clock with manual override on-off switch.
2. Enclosure: NEMA 250, Type 1, suitable for wall mounting.
3. Operation of Pump: On or off.
4. Transformer: Provide if required.
5. Power Requirement: 120-V ac.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of domestic-water-piping system to verify actual locations of connections before pump installation.

3.2 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install in-line, sealless centrifugal pumps with shaft horizontal unless otherwise indicated.

C. Install horizontally mounted, in-line, close-coupled centrifugal pumps with shaft(s) horizontal.

D. Install vertically mounted, in-line, close-coupled centrifugal pumps with shaft vertical.

E. Pump Mounting: Install vertically mounted, in-line, close-coupled centrifugal pumps with cast-iron base mounted on concrete base using elastomeric pads. Comply with requirements for concrete base specified in Section 033053 "Miscellaneous Cast-in-Place Concrete."

1. Minimum Deflection: 1/4 inch.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.

F. Install continuous-thread hanger rods and spring hangers of size required to support pump weight.

1. Comply with requirements for vibration isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment." Fabricate brackets or supports as required.
2. Comply with requirements for hangers and supports specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

G. Install pressure switches in water supply piping.

H. Install thermostats in hot-water return piping.

I. Install timers on wall in engineer's office.

J. Install time-delay relays in piping between water heaters and hot-water storage tanks.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps to allow service and maintenance.

C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.

1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:

a. Horizontally mounted, in-line, close-coupled centrifugal pumps.
b. Comply with requirements for flexible connectors specified in Section 221116 "Domestic Water Piping."

D. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," Section 220523.14 "Check Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping," and comply with requirements for strainers specified in Section 221119 "Domestic Water Piping Specialties."

1. Install pressure gage[and snubber] at suction of each pump and pressure gage[and snubber] at discharge of each pump. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Comply with requirements for pressure gages and snubbers specified in Section 220519 "Meters and Gages for Plumbing Piping."

E. Connect pressure switches, thermostats, time-delay relays, timers to pumps that they control.

F. Interlock pump between water heater and hot-water storage tank with water heater burner and time-delay relay.

3.4 IDENTIFICATION

A. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment" for identification of pumps.

3.5 ADJUSTING

A. Adjust domestic water pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust initial temperature set points.

C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION 221123

SECTION 221316 - SANITARY WASTE AND VENT PIPING

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:

1. Hubless, cast-iron soil pipe and fittings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For hubless, single-stack drainage system. Include plans, elevations, sections, and details.

1.4 FIELD CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without Owner's written permission.

1.5 WARRANTY

A. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water.

2. Waste, Force-Main Piping: 50 psig.

2.2 PIPING MATERIALS

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Charlotte Pipe and Foundry Company.

B. Pipe and Fittings: ASTM A 888 or CISPI 301.

C. CISPI, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ANACO-Husky.
b. Charlotte Pipe and Foundry Company.
c. MIFAB, Inc.
d. Mission Rubber Company, LLC; a division of MCP Industries.
e. Tyler Pipe; a subsidiary of McWane Inc.

2. Standards: ASTM C 1277 and CISPI 310.
3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

D. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ANACO-Husky.
b. Charlotte Pipe and Foundry Company.
c. Tyler Pipe; a subsidiary of McWane Inc.

2. Standards: ASTM C 1277 and ASTM C 1540.
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

E. Cast-Iron, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Charlotte Pipe and Foundry Company.

b. MG Piping Products Company.

2. Standard: ASTM C 1277.
3. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

PART 3 EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
2. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.

1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.

a. Straight tees, elbows, and crosses may be used on vent lines.

3. Do not change direction of flow more than 90 degrees.
4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

    a. Reducing size of waste piping in direction of flow is prohibited.

K. Lay buried building waste piping beginning at low point of each system.

1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
3. Maintain swab in piping and pull past each joint as completed.

L. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Waste: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Waste Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

N. Install steel piping according to applicable plumbing code.

O. Install stainless-steel piping according to ASME A112.3.1 and applicable plumbing code.

P. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

Q. Install aboveground ABS piping according to ASTM D 2661.

R. Install aboveground PVC piping according to ASTM D 2665.

S. Install underground [ABS] [and] [PVC] piping according to ASTM D 2321.

T. Install engineered soil and waste and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
2. Hubless, Single-Stack Drainage System: Comply with ASME B16.45 and hubless, single-stack aerator fitting manufacturer's written installation instructions.
3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

U. Install underground, ductile-iron, force-main piping according to AWWA C600.

1. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints.
2. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
3. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.

V. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."

1. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.

W. Install force mains at elevations indicated.

X. Plumbing Specialties:

1. Install backwater valves in sanitary waster gravity-flow piping.

a. Comply with requirements for backwater valves specified in Section 221319 "Sanitary Waste Piping Specialties."

2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.

a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
b. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."

3. Install drains in sanitary waste gravity-flow piping.

a. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."

Y. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

Z. Install sleeves for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

AA. Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

BB. Install escutcheons for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.

C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1.

1. Cut threads full and clean using sharp dies.
2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
c. Do not use pipe sections that have cracked or open welds.

E. Join stainless-steel pipe and fittings with gaskets according to ASME A112.3.1.

F. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

G. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

H. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

I. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 appendixes.
3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 appendixes.

3.4 VALVE INSTALLATION

A. Comply with requirements in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," Section 220523.14 "Check Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping" for general-duty valve installation requirements.

B. Shutoff Valves:

1. Install shutoff valve on each sewage pump discharge.
2. Install gate or full-port ball valve for piping NPS 2 and smaller.
3. Install gate valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
3. Install backwater valves in accessible locations.
4. Comply with requirements for backwater valve specified in Section 221319 "Sanitary Waste Piping Specialties."

3.5 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Install individual, straight, horizontal piping runs:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Install hangers for soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

C. Install hangers for piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Support horizontal piping and tubing within 12 inches of each fitting[, valve,] and coupling.

E. Support vertical runs of soil piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

F. Support vertical runs of piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect waste and vent piping to the following:

1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Install horizontal backwater valves [with cleanout cover flush with floor] [in pit with pit cover flush with floor] <Insert description>.
6. Comply with requirements for [backwater valves] [cleanouts] [and] [drains] specified in Section 221319 "Sanitary Waste Piping Specialties."
7. Equipment: Connect waste piping as indicated.

    a. Provide shutoff valve if indicated and union for each connection.
    b. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Connect force-main piping to the following:

1. Sanitary Sewer: To exterior force main.
2. Sewage Pump: To sewage pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

F. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.7 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping.

B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

    a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.

    a. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.

    a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
    b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
    c. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.

    a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.
    b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
    c. Air pressure must remain constant without introducing additional air throughout period of inspection.
    d. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.

    a. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials.

    a. Isolate test source and allow to stand for four hours.
    b. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.9 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.10 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping [NPS 4 and smaller] <Insert pipe size range> shall be[any of] the following:

1. Hubless, cast-iron soil pipe and fittings[and hubless, single-stack aerator fittings]; [CISPI] [heavy-duty] hubless-piping couplings; and coupled joints.

C. Aboveground, soil and waste piping [NPS 5 and larger] <Insert pipe size range> shall be[any of] the following:

1. Hubless, cast-iron soil pipe and fittings [and hubless, single-stack aerator fittings]; [CISPI] [heavy-duty] hubless-piping couplings; and coupled joints.

D. Aboveground, vent piping [NPS 4 and smaller] <Insert pipe size range> shall be[any of] the following:

1. Hubless, cast-iron soil pipe and fittings; [CISPI] [heavy-duty] hubless-piping couplings; and coupled joints.

E. Aboveground, vent piping [NPS 5 and larger] <Insert pipe size range> shall be[any of] the following:

1. Hubless, cast-iron soil pipe and fittings; [CISPI] [heavy-duty] hubless-piping couplings; and coupled joints.
2. PVC pipe, PVC socket fittings, and solvent-cemented joints.

F. Underground, soil, waste, and vent piping [NPS 4 and smaller] <Insert pipe size range> shall be[any of] the following:

1. Hubless, cast-iron soil pipe and fittings; cast-iron hubless-piping couplings; and coupled joints.
2. PVC pipe, PVC socket fittings, and solvent-cemented joints.

G. Underground, soil and waste piping [NPS 5 and larger] <Insert pipe size range> shall be[any of] the following:

1. Hubless, cast-iron soil pipe and fittings; cast-iron hubless-piping couplings; coupled joints.

H. Aboveground sanitary-sewage force mains [NPS 2-1/2 to NPS 6] <Insert pipe size range> shall be[any of] the following:

1. Grooved-end, galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.

I. Underground sanitary-sewage force mains [NPS 4 and smaller] <Insert pipe size range> shall be[any of] the following:

1. Fitting-type transition coupling for piping smaller than NPS 1-1/2 and pressure transition coupling for NPS 1-1/2 and larger if dissimilar pipe materials.

END OF SECTION 221316

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

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:

1. Backwater valves.
2. Cleanouts.
3. Miscellaneous sanitary drainage piping specialties.

1.3 DEFINITIONS

A. ABS: Acrylonitrile butadiene styrene.

B. PVC: Polyvinyl chloride.

PART 2 PRODUCTS

2.1 BACKWATER VALVES

A. Horizontal, Cast-Iron Backwater Valves :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Jay R. Smith Mfg Co; a division of Morris Group International.
   b. MIFAB, Inc.
   c. WATTS.

2. Standard: ASME A112.14.1.
3. Size: Same as connected piping.
4. Body: Cast iron.
5. Cover: Cast iron with threaded access check valve.
6. End Connections: Hub and spigot or hubless.
7. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang open for airflow unless subject to backflow condition.
8. Extension: ASTM A74, Service Class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

2.2 CLEANOUTS

A. Cast-Iron Exposed Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Jay R. Smith Mfg Co; a division of Morris Group International.
    b. MIFAB, Inc.
    c. WATTS.

2. Standard: ASME A112.36.2M.
3. Size: Same as connected drainage piping
4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Cast-Iron Exposed Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Sioux Chief Manufacturing Company, Inc.

2. Standard: ASME A112.36.2M for adjustable housing heavy-duty, adjustable housing threaded, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Body or Ferrule: Cast iron.
5. Clamping Device: Not required.
6. Outlet Connection: Threaded.
7. Closure: Cast-iron plug.
8. Adjustable Housing Material: Cast iron with .
9. Riser: ASTM A74, Service Class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure Plug:

    a. Brass Cast iron.
    b. Countersunk or raised head.
    c. Drilled and threaded for cover attachment screw.
    d. Size: Same as or not more than one size smaller than cleanout size.

2.3 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

B. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install backwater valves in building drain piping.

1. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Assemble open drain fittings and install with top of hub [1 inch] [2 inches] <Insert dimension> above floor.

F. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.

G. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.

H. Install vent caps on each vent pipe passing through roof.

I. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

J. Install wood-blocking reinforcement for wall-mounting-type specialties.

K. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 PIPING CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment, to allow service and maintenance.

3.3 LABELING AND IDENTIFYING

A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.

1. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319

SECTION 221319.13 - SANITARY DRAINS

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:

1. Floor drains.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene styrene.

B. FRP: Fiberglass-reinforced plastic.

C. HDPE: High-density polyethylene.

D. PE: Polyethylene.

E. PP: Polypropylene.

F. PVC: Polyvinyl chloride.

PART 2 PRODUCTS

2.1 DRAIN ASSEMBLIES

A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic sanitary piping specialty components.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains <Insert drawing designation if any>:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Jay R. Smith Mfg. Co.
b. MIFAB, Inc.

c. Prier Products, Inc.
d. Sioux Chief Manufacturing Company, Inc.
e. Wade; a subsidiary of McWane Inc.
f. WATTS.
g. Zurn Industries, LLC.

2. Standard: ASME A112.6.3 with backwater valve.
3. Body Material: Gray iron.
4. Outlet: Bottom.
5. Top or Strainer Material: Bronze Stainless steel.
6. Top Shape: Round Square.
7. Trap Material: Cast iron.
8. Trap Pattern: Standard P-trap.
9. Trap Features: Trap-seal primer valve drain connection.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
3. Set with grates depressed according to the following drainage area radii:

a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.

a. Maintain integrity of waterproof membranes where penetrated.

5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

B. Install trench drains at low points of surface areas to be drained.

1. Set grates of drains flush with finished surface, unless otherwise indicated.

C. Comply with ASME A112.3.1 for installation of stainless-steel channel drainage systems.

1. Install on support devices, so that top will be flush with adjacent surface.

D. Install FRP channel drainage system components on support devices, so that top will be flush with adjacent surface.

E. Install plastic channel drainage system components on support devices, so that top will be flush with adjacent surface.

F. Install open drain fittings with top of hub 1 inch above floor.

3.2 CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements in Section 221319 "Sanitary Waste Piping Specialties" for backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.

C. Comply with requirements in Section 221323 "Sanitary Waste Interceptors" for grease interceptors, grease-removal devices, oil interceptors, sand interceptors, and solid interceptors.

D. Install piping adjacent to equipment to allow service and maintenance.

E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 LABELING AND IDENTIFYING

A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319.13

SECTION 221423 - STORM DRAINAGE PIPING SPECIALTIES

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:

1. Metal roof drains.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 PRODUCTS

2.1 METAL ROOF DRAINS

A. Cast-Iron, Medium-Sump, General-Purpose Roof Drains <Insert drawing designation if any>:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Jay R. Smith Mfg Co; a division of Morris Group International.
b. MIFAB, Inc.
c. Wade; a subsidiary of McWane Inc.
d. WATTS.
e. Zurn Industries, LLC.

2. Standard: ASME A112.6.4.
3. Body Material: Cast iron.
4. Dimension of Body: 8- to 12-inch diameter.
5. Flow-Control Weirs: Not required.
6. Outlet: Bottom.
7. Outlet Type: No hub.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install roof drains at low points of roof areas in accordance with roof membrane manufacturer's written installation instructions.

1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
2. Install expansion joints, if indicated, in roof drain outlets.
3. Position roof drains for easy access and maintenance.

B. Install downspout adapters on outlet of back-outlet parapet roof drains and connect to sheet metal downspouts.

C. Install downspout boots at grade with top 12 inches above grade. Secure to building wall.

D. Install downspout nozzles at exposed bottom of conductors where they spill onto grade.

E. Install cleanouts in aboveground piping and building drain piping in accordance with the following instructions unless otherwise indicated:

1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
3. Locate cleanouts at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate cleanouts at base of each vertical storm piping conductor.

F. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

G. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

H. Install test tees in vertical conductors and near floor.

I. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.

J. Assemble channel drainage system components in accordance with manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.

K. Install through-penetration firestop assemblies for penetrations of fire- and smoke-rated assemblies.

1. Comply with requirements in Section 078413 "Penetration Firestopping."

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Section 221413 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 INSTALLATION OF FLASHING

A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221423

SECTION 223300 - ELECTRIC, DOMESTIC-WATER HEATERS

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 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.3 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Warranty Periods: From date of Substantial Completion.

a. Commercial, Electric, Storage, Domestic-Water Heaters:

1) Storage Tank: Five years.
2) Controls and Other Components: Five years.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

B. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

C. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.

D. Commercial, Electric, Storage, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. A. O. Smith Corporation.

2. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
3. Standard: UL 1453.
4. Storage-Tank Construction: ASME-code, steel vertical arrangement.

    a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.

        1) NPS 2 and Smaller: Threaded ends in accordance with ASME B1.20.1.

    b. Pressure Rating: 150 psig.
    c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.
    d. Anode Rod: Replaceable magnesium.
    e. Drain Valve: Corrosion-resistant metal with hose-end connection.
    f. Insulation: Comply with ASHRAE/IES 90.1.
    g. Jacket: Steel with enameled finish or high-impact composite material.
    h. Temperature Control: Adjustable thermostat.
    i. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
    j. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select one relief valve with sensing element that extends into storage tank.

2.2 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Expansion Tanks:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. A. O. Smith Corporation.

2. Source Limitations: Obtain domestic-water expansion tanks from single source from single manufacturer.
3. Description: Steel pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
4. Construction:

    a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
    b. Air-Charging Valve: Factory installed.
    c. Working-Pressure Rating: 100 psig.

B. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads.

C. Piping-Type Heat Traps: Field-fabricated piping arrangement in accordance with ASHRAE/IES 90.1.

D. Heat-Trap Fittings: ASHRAE/IES 90.1.

E. Pressure-Reducing Valves: ASSE 1003 for water. Set at 25-psig- maximum outlet pressure unless otherwise indicated.

F. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valves with sensing element that extends into storage tank.

G. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than working-pressure rating of domestic-water heater.

H. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.

I. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.

J. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Include dimension that will support bottom of domestic-water heater a minimum of [18 inches] <Insert dimension> above the floor.

K. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, in accordance with ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test[commercial] domestic-water heaters to minimum of one and one-half times pressure rating before shipment.

C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base. Comply with requirements for concrete bases specified in Section 033000 "Cast-in-Place Concrete."

1. Exception: Omit concrete bases for commercial, electric, domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
2. Maintain manufacturer's recommended clearances.
3. Arrange units so controls and devices that require servicing are accessible.

4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Install anchor bolts to elevations required for proper attachment to supported equipment.
8. Anchor domestic-water heaters to substrate.

B. Install electric, domestic-water heaters level and plumb, in accordance with layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping."

C. Install commercial, electric, domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

D. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend domestic-water heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

E. Install combination temperature-and-pressure relief valves in water piping for electric, domestic-water heaters without storage. Extend domestic-water heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

F. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."

G. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."

H. Install thermometers on inlet and outlet piping of residential, solar, electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."

I. Assemble and install inlet and outlet piping manifold kits for multiple electric, domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each electric, domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each electric, domestic-water heater outlet. Comply with requirements for valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping," and comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."

J. Install pressure-reducing valve with integral bypass relief valve in electric, domestic-water booster-heater inlet piping and water hammer arrester in booster-heater outlet piping. Set pressure-reducing valve for outlet pressure of 25 psig. Comply with requirements for pressure-reducing valves and water hammer arresters specified in Section 221119 "Domestic Water Piping Specialties."

K. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.

L. Fill electric, domestic-water heaters with water.

M. Charge domestic-water expansion tanks with air to required system pressure.

N. Install dielectric fittings in all locations where piping of dissimilar metals is to be joined. The wetted surface of the dielectric fitting contacted by potable water shall contain less than 0.25 percent of lead by weight.

3.2 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections[with the assistance of a factory-authorized service representative].

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Train Owner's maintenance personnel to adjust, operate, and maintain commercial, electric, domestic-water heaters. Training shall be a minimum of two hour(s).

END OF SECTION 223300

SECTION 224213.13 - COMMERCIAL WATER CLOSETS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Floor-mounted, bottom-outlet water closets.
2. Floor-mounted, back-outlet water closets.
3. Wall-mounted water closets.
4. Flushometer valves.
5. Supports.

1.2 DEFINITIONS

A. Standard-Efficiency Flush Volume: 1.6 gal. per flush.

B. High-Efficiency Flush Volume: 1.28 gal. or less per flush.

C. WaterSense Fixture: Water closet and/or flushometer valve/tank certified by the EPA to meet the WaterSense performance criteria.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water closets.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves[and electronic sensors] to include in operation and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than one of each type.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Standards:

1. Comply with ASME A112.19.2/CSA B45.1 for water closets.
2. Comply with ASME A112.19.5/CSA B45.15 for flush valves and spuds for water closets and tanks.
3. Comply with ASSE 1037/ASME A112.1037/CSA B125.37 for flush valves.
4. Comply with IAMPO/ANSI Z124.5 for water-closet (toilet) seats.
5. Comply with ASME A112.6.1M for water-closet supports.
6. Comply with ICC A117.1 for ADA-compliant water closets.
7. Comply with ASTM A1045 for flexible PVC gaskets used in connection of vitreous china water closets to sanitary drainage systems.
8. Comply with ASME A112.4.3 for plastic fittings used in connection of vitreous china water closets to sanitary drainage systems.

2.2 FLOOR-MOUNTED, BOTTOM-OUTLET WATER CLOSETS

A. Water Closets - Floor Mounted, Bottom Outlet, Top Spud: Refer to Plumbing Schedule for selection

1. Source Limitations: Obtain water closets from single source from single manufacturer.
2. Water Closet to support 1.0 gpf

2.3 WALL-MOUNTED WATER CLOSETS

A. Water Closets - Wall Mounted, Top Spud: Refer to Plumbing Schedule for selection

1. Source Limitations: Obtain water closets from single source from single manufacturer.
2. Water Closet to support 1.0 gpf

2.4 SUPPORTS

A. Water-Closet Carrier:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Jay R. Smith Mfg Co; a division of Morris Group International.
   b. MIFAB, Inc.
   c. WATTS.
   d. Zurn Industries, LLC.

2. Source Limitations: Obtain water-closet carrier from single source from single manufacturer.

3. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water-supply piping and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.

B. Examine walls and floors for suitable conditions where water closets will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Water-Closet Installation:

1. Install level and plumb.
2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
3. Install accessible, wall-mounted water closets at mounting height in accordance with ICC A117.1.

B. Flushometer-Valve Installation:

1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
4. Install actuators in locations easily reachable for people with disabilities.
5. Install new batteries in battery-powered, electronic-sensor mechanisms.

C. Install toilet seats on water closets.

D. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.
3. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

E. Joint Sealing:

1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to water-closet color.
3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 PIPING CONNECTIONS

A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

D. Where installing piping adjacent to water closets, allow space for service and maintenance.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least [1/2 inch] <Insert dimensions> high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.6 ADJUSTING

A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.

B. Adjust water pressure at flushometer valves to produce proper flow.

C. Install new batteries in battery-powered, electronic-sensor mechanisms.

3.7 CLEANING AND PROTECTION

A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed water closets and fittings.

C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

END OF SECTION 224213.13

SECTION 224216.13 - COMMERCIAL LAVATORIES

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:

1. Enameled, cast-iron, counter-mounted lavatories.
2. Vitreous-china, counter-mounted lavatories.
3. Enameled, cast-iron, wall-mounted lavatories.
4. Vitreous-china, wall-mounted lavatories.
5. Supply fittings.
6. Waste fittings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lavatories and faucets to include in operation and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Servicing and adjustments of automatic faucets.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Faucet Washers and O-Rings: Equal to [10] <Insert number> percent of amount of each type and size installed.
2. Faucet Cartridges and O-Rings: Equal to [5] <Insert number> percent of amount of each type and size installed.

PART 2 PRODUCTS

2.1 ENAMELED, CAST-IRON, COUNTER-MOUNTED LAVATORIES

A. Refer to Plumbing Schedule for Selection:

1. Provide faucet at 0.35gpm or less to meet LEED criteria

2.2 VITREOUS-CHINA, WALL-MOUNTED LAVATORIES

A. Refer to Plumbing Schedule for Selection:

1. Provide faucet at 0.35gpm or less to meet LEED criteria

2.3 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF 61 and NSF 372 for supply-fitting materials that will be in contact with potable water.

B. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless steel wall flange.

C. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

2.4 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.

C. Trap:

1. Size: NPS 1-1/4.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.

B. Examine counters and walls for suitable conditions where lavatories will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install lavatories level and plumb in accordance with roughing-in drawings.

B. Install supports, affixed to building substrate, for wall-mounted lavatories.

C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, in accordance with ICC A117.1.

D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

E. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.3 PIPING CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least [1/2 inch] <Insert dimension> high.

3.5 ADJUSTING

A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.

B. Install new batteries in battery-powered, electronic-sensor mechanisms.

3.6 CLEANING AND PROTECTION

A. After completing installation of lavatories, inspect and repair damaged finishes.

B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed lavatories and fittings.

D. Do not allow use of lavatories for temporary facilities unless approved in writing by Owner.

END OF SECTION 224216.13

SECTION 230000 - MECHANICAL GENERAL REQUIREMENTS

PART 1 GENERAL

1.1 DESCRIPTION

A. All work under this Section shall comply with the requirements of General Conditions, Supplemental Conditions, Special Conditions and Division 1 - General Requirements, and shall include all Sections of Division 230000 and shall apply to all Work specified, indicated in the Drawings, and as required to furnish a complete installation of mechanical systems for the Project. Review all Sections of the Specifications for related work and coordinate the work of this Section with all other Sections.

B. Furnish all labor, services, materials, tools, equipment, appliances, facilities, transportation and incidental work and appurtenances required to furnish a complete and properly operating system.

C. The Contractor shall refer to the architectural interior details, floor plans, elevations, and the structural and other Contract Drawings and shall coordinate the work with that of the other trades to avoid interference. The plans are diagrammatic and show the general arrangement of the fixtures, equipment, piping and ductwork. All dimensions and existing conditions shall be the responsibility the Contractor. Before proceeding with work check and verify all dimensions.

D. The Contractor shall assume all responsibility for fitting of materials and equipment to other parts of equipment and structure. Make adjustments that may be necessary or as requested, in order to resolve space problems, preserve headroom, and avoid architectural openings, structural members and work of other trades. Where existing pipes, conduits and/or ducts prevent installation of new work as indicated, relocate, or arrange for relocation, of existing pipes, conduits and/or ducts.

E. Where the project involves interface with existing building and site systems, the Consultant has used reasonable care to identify existing utilities and services. The Contractor is responsible to thoroughly familiarize themselves with existing conditions and be aware that in some cases information is not available i.e. concealed conditions, which exist in the existing building affected by this work.

F. Drawings are diagrammatic and do not represent to show or list every item to be provided and specifications may include performance language. When an item not shown or listed, is necessary for proper operation of the system and/or equipment in accordance with the diagrammatic and performance based nature of areas of the documents, the Contractor shall provide the item which will allow the system to function properly at no increase in Contract Sum.

G. Work shall include, but shall not be limited to, the following:

1. Tie-ins to existing water piping.
2. Relocation of existing systems which interfere with new construction.
3. Removal of existing ductwork, piping and equipment to be abandoned.
4. Coordinate maintenance of existing services during construction with Owner.
5. Special coordination of chases and plenums.
6. Hoisting and rigging required to complete work of this section.

7. Sleeves, inserts and hangers.
8. Flexible connections for pumps and other vibrating and rotating equipment.
9. Equipment bases and supports.
10. Vibration isolators, seismic restraints and inertia blocks.
11. Motors.
12. Complete hot water system including pumps, expansion tanks, piping, valves, fittings and other hardware.
13. Complete chilled water system including pumps, expansion tanks, piping, valves, fittings and other hardware.
14. Complete refrigerant system including piping, valves, fittings and other hardware.
15. Expansion joints, anchors and guides.
16. Pressure gauges and thermometers.
17. Water treatment equipment and chemicals, and testing.
18. Radiant systems such chilled beams, radiant ceilings and radiant floors.
19. Sheet metal work.
20. Complete air distribution system including low and medium pressure ductwork, diffusers, registers, grilles, dampers, etc.
21. Insulation for duct, piping, equipment and tanks.
22. Air handling units, including fans, filters, motors, and mixing boxes.
23. Air volume terminal boxes.
24. Sound Attenuators.
25. Exhaust and ventilating air fans.
26. Rooftop supply and exhaust fans.
27. Condensate piping from chilled water coil drain pans.
28. Unit heaters.
29. Cabinet heaters.
30. Prime painting.
31. Pipe, duct, valve and equipment identification.
32. Instruction manual and start up instructions.
33. Testing and balancing.
34. Commissioning.
35. Cleaning.
36. Automatic temperature controls, air volume controls and other controls.
37. Power wiring to all DDC control panels and controls.

H. Related work specified elsewhere: The following work, unless otherwise noted is not included in this section shall be performed in other sections:

1. Electric power wiring for all equipment. See division 260000.
2. Provision of circuit breakers testing and connections for DDC control power wiring.
3. Gypsum drywall enclosures of supply and return ductwork on all rooftop air handlers, supply and return shafts, as shown on drawings.
4. Excavation and backfill.
5. Concrete work, including concrete housekeeping pads and other pads and blocks for vibrating and rotating equipment, duct bank envelopes and cast in place manholes and handholes, except as part of an inertia base. See Division 3
6. Cutting and patching of masonry, concrete, tile and other parts of structure, with the exception of drilling for hangers and providing holes and openings in metal deck.
7. Flashing of wall and roof penetrations.
8. Installation of access panels in floors, walls, furred spaces or above ceilings
9. Outdoor air intake and exhaust louvers.
10. Undercutting of doors and door louvers
11. Partitions and Painting (except as specifically indicated) See Division.
12. Structural supports necessary to distribute loading from equipment to roof or floor, except as specified herein.

13. Foundation drainage systems and site drainage structures.
14. Paving
15. Thermal and sound insulation in partitions and ceilings.

1.2 QUALITY ASSURANCE

A. General:

1. All equipment and accessories shall be the product of a manufacturer regularly engaged in its manufacturer.
2. All equipment and accessories shall be new and free from defects.
3. Supply all equipment and accessories in compliance with the applicable standards listed in this Section and with all applicable National, State and Local Codes.
4. All items of a given type shall be the product of the same manufacturer.
5. Install work by craftsmen skilled in trade involved and by apprentices as indicated in the general conditions. Rough work will be rejected.
6. The subcontractor must, within the last five years, prior to the bid opening, have successfully completed in a timely fashion at least three projects similar in scope and type to the required work.

B. Requirement of regulatory agencies:

1. In accordance with requirements of Division 1 and as specified herein.
2. Nothing in the Drawings or Specifications shall be construed to permit Work not conforming to applicable laws, ordinances, rules or regulations.
3. When Drawings or Specifications exceed requirements of applicable laws, ordinances, rules or regulations, Drawings and Specifications take precedence.
4. It is not the intent of Drawings and Specifications to repeat requirements of codes except where necessary for completeness or clarity.
5. If any of the requirements of the above are in conflict with one another, or with the requirements of these specifications, the most stringent requirements shall govern.
6. Local codes as required by the Town of Cornwall, NY.

C. Green Building Performance Requirements

1. The Contractor shall implement practices and procedures to meet the Project’s Green Building requirements. The Contractor shall ensure that the requirements related to these goals, as defined in Section 018113: “Sustainable Design Requirements”, and as specified in this Section, are implemented to the fullest extent. Substitutions or other changes to the work shall not be proposed by the Contractor or their sub-contractors if such changes compromise the stated Green Building Performance Criteria.
2. VOC Limits: All field-applied adhesives, sealants, primers, paints and coatings used on the interior of the building shall meet the volatile organic compound (VOC) and chemical component limitations as defined in Section 018115 "Volatile Organic Compound Limits", VOC contents shall be identified and documented.
3. Insulation:

a. Fiberglass Insulation: Fiberglass insulation will contain no formaldehyde-based binders or will be third-party certified for conformance with Greenguard or Indoor Advantage Gold. (Many fiberglass insulation products are bonded with a formaldehyde resin, which can contribute to unwanted indoor emissions.) Unfaced fiberglass batt insulation shall not be used above suspended ceilings. Fiberglass board products used in plenums and shafts or for insulating ductwork must be wrapped or enclosed.
b. Duct Acoustical Insulation: Insulation shall only be installed in duct where needed for sound attenuation, not solely for thermal insulation or condensation control. Insulation shall be installed only in clean and dry areas. Mechanical sound insulation materials within duct will consist of an impervious, non-porous coating that prevents dust from accumulating in the insulating materials and resists damage and wear.
c. Mineral Fiber Firestopping: Materials exposed to supply or return air plenums, or located above suspended ceilings, must be encapsulated or fully sealed to prevent direct exposure of the mineral or glass fibers to the plenum. Where sealants are used to encapsulate the fibrous materials (e.g., smoke sealants used at firestopping joints), the sealants shall meet the VOC requirements of Section 018115 “Volatile Organic Compound (VOC) Limits For Adhesives, Sealants, Paints & Coatings.

4. Elimination of CFCs and HCFCs:

a. Ozone Protection: Building cooling equipment shall contain no refrigerants other than the following: HCFC-123, HFC-134a, HFC-245fa, HFC-407c, or HFC 410a.
b. Fire suppression systems may not contain ozone-depleting substances such as halons, CFCs or HCFCs. Any extruded polystyrene insulation (XPS) and closed-cell spray foam polyurethane insulation shall not be manufactured with hydrochlorofluorocarbon (HCFC) blowing agents.

1.3 APPLICABLE PUBLICATION

A. Materials and equipment shall be manufactured, installed and tested as specified in latest editions of applicable publications, standards, rulings and determinations of:

1. Local and state building, plumbing, mechanical, electrical, fire and health department codes.
2. American Gas Association (AGA).
3. National Fire Protection Association (NFPA).
4. American Insurance Association (AIA) (formerly National Board of Fire Underwriters).
5. Occupational Safety and Health Act (OSHA)
6. Underwriter’s Laboratories (UL).
7. Factory Mutual Association (FM).
8. National Electric Code (NEC)
9. Environmental Protection Agency (EPA)
10. National Bureau of Standards (NBS)
11. Owner’s Insurance Underwriter.

B. All materials and equipment shall be listed by Underwriters” Laboratories (UL), and approved by ASME, ANSI, ASTM, AGA, and NEC for intended service.

C. Most recent editions of applicable specifications and publications of the following organizations form part of these Contract Documents.

1. American National Standards Institute (ANSI)
2. American Society of Mechanical Engineers (ASME)
3. National Electrical Manufacturers' Association (NEMA)
4. American Society for Testing and Materials (ASTM)
5. American Water Works Association (AWWA)
6. Plumbing and Drainage Institute (PDI)
7. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
8. Air Moving and Conditioning Association (AMCA)
9. Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
10. Air Conditioning and Refrigeration Institute (ARI)
11. Hydraulic Institute (HI)
12. Associated Air Balance Council (AABC)
13. Manufacturers Standardization Society of the Valves & Fittings Industry (MSS)
14. Adhesive and Sealant Council (ASC)
15. American Society of Sanitary Engineering (ASSE)
16. American Welding Society (AWS)
17. Institute of Electrical and Electronic Engineers (IEEE)
18. Insulated Cable Engineers Association (ICEA)
19. Certified Ballast Manufacturers (CMB)
20. Illuminating Engineering Society (IES)
21. National Environmental Balancing Bureau (NEBB)
22. Tubular Exchanger Manufacturer's Association (TEMA)
23. Thermal Insulation Manufacturers Association (TIMA)

D. Specific reference is made to following NFPA codes which contain an exceptionally high quantity of mechanical, electrical, and fire protection requirements.

1. No. 13- Installation of sprinkler systems
2. No. 14- Installation of standpipe and hose systems
3. No. 20- Installation of centrifugal fire pumps.
4. No. 30- Combustible Liquids
5. No. 45- Fire Protection for Laboratories
6. No. 70- National Electric Code
7. No. 72D- Proprietary Protective Signaling Systems
8. No. 72E- Automatic Fire Detectors

1.4 DEFINITIONS

A. “Provide” means “furnish and install”, complete, the specified material, equipment or other item and perform all required labor to make a finished and properly operational installation.

B. “Furnish” means to purchase and deliver to project site complete with all appurtenance and support. “Install” means to unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project

C. “Consultant” means “Prime Design Consultant”. An individual or organization engaged by the owner or the architect to render professional engineering consulting services complementing or supplementing the architect’s services concerning the content of the Mechanical, Electrical, Plumbing & Fire Protection sections of specifications.

D. “Owner” means the individual or entity with whom Contractor has entered into the Agreement for whom the Work is to be performed

E. “Construction Manager Advisor” or “CMA” means the Construction Manager that provides services to advise the Owner and Architect on design and materials decisions during the design and document development process. The CMA coordinates the entire design process using his skills and knowledge of construction to clarify cost and time considerations of design decisions, to advise on feasibility of single, multiple-contract or fast-track delivery systems, recommend the construction process, and to handle the bidding and award, as well as to manage the construction of the Project.

F. “Construction Manager Constructor” or “CMC” means the Construction Manager that in addition to acting as an advisor to the Owner during a design period, assumes responsibility for the construction of the Project. The CMC become contractually bound to provide the labor and material for the Project. The CMC may also serve as administrator of multiple prime contract construction; however, some states prohibit that practice.

G. General Contractor/ Prime Contractor means the contractor who contracts with a property owner and, in turn, employs a subcontractor or subcontractors to perform some of all of the work.

H. “Contractor” or “Subcontractor” means the trade contractor responsible for the work in this Division of the specification.

I. “Owner’s Representative” means the Consultant, Engineer, or other Specialty Consultant retained by the Owner.

J. “RFI” means “Contractor’s Request for Information”.

K. "Above Grade": Not buried in the ground and not embedded in concrete slab on ground.

L. “Accessible”: Ability to perform recommended maintenance without removal of services or equipment and requiring no special platforms.

M. "Actuating" or "Control" Devices: Automatic sensing and switching devices such as thermostats, pressure, float, electro-pneumatic switches and electrodes controlling operation of equipment.

N. "Below Grade": Buried in the ground or embedded in concrete slab on ground.

O. "Concealed": Embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures. In general, any item not visible or directly accessible.

P. "Connect": Complete hook-up of item with required service.

Q. "Exposed": Not installed underground or "concealed."

R. "Indicated," "Shown" or " "Noted": As indicated, shown or noted on Drawings or Specifications.

S. "Install": To erect, mount and connect complete with related accessories.

T. "Piping": Pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation, and related items.

U. "Reviewed," "Satisfactory" or "Directed": As reviewed, satisfactory, or directed by or to Architect/Engineer/Owner.

V. "Rough-In": Provide all indicated services in the necessary arrangement suitable for making final connections to fixture or equipment.

W. "Shall": An exhortation or command to complete the specified task.

X. "Similar" or "Equal": Of base bid manufacture, equal in materials, weight, size, design, and efficiency of specified products.

Y. "Supply": To purchase, procure, acquire and deliver complete with related accessories.

Z. “Typical” or “Typ”: Exhibiting the qualities, traits, or characteristics that identify a kind, class, number, group or category. Of or relating to a representative specimen. Application shall apply to all other similarly identified on plan or detail.

AA. "Will": A desire to complete the specified task. Allows some flexibility in application as opposed to "Shall."

BB. "Wiring": Raceway, fittings, wire, boxes and related items.

CC. "Work": Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.

DD. Reference by abbreviation may be made in the specifications and the Contract Drawings for Mechanical and Electrical Work in accordance with the following list:

1.	HVAC	Heating, Ventilating and Air Conditioning
2.	GC	General Contractor
3.	AC	Air Conditioning
4.	H&V	Heating and Ventilating
5.	AWG	American Wire Gauge
6.	BWG	Birmingham Wire Gauge
7.	USS	United States Standards
8.	B&S	Brown and Sharpe
9.	OS&Y	Outside Screw and Yoke
10.	IBBM	Iron Body Brass Mounted
11.	WSP	Working Steam Pressure
12.	PSIG	Pounds Per Square Inch
13.	PRV	Pressure Reducing Valve
14.	GPM	Gallons Per Minute
15.	MBH	Thousand BTU per Hour
16.	BTU	British Thermal Units
17.	WG	Water Gage
18.	LB	Pound (Also shown as: #)

19. ASME American Society of Mechanical Engineers
20. ASTM American Society of Testing Materials
21. ABMA American Boiler Manufacturer's Association
22. ASA American Standards Association

1.5 SCOPE

A. Perform work and provide material and equipment as shown on the drawings and/or as specified and/or as indicated in this section of the specifications. Completely coordinate all work of this section with work of other trades and provide a complete and fully functional installation

B. Drawings and Specifications form complimentary requirements; provide work specified and not shown, and work shown and not specified as though explicitly require by both. Although work is not specifically shown or specified, provide supplementary or miscellaneous items, appurtenances, devices and materials obviously necessary for sound, secure and complete installation.

C. Give notices, file plans, obtain permits and licenses, pay fees and back-charges, and obtain necessary approvals from authorities that have jurisdiction as required to perform work in accordance with all legal requirements and with Specifications, Drawings, Addenda and Change Orders, all of which are part of Contract Documents.

D. Contractor shall be responsible with obtaining all the final inspection as required by Local Code and ordinances.

1.6 CONTRACT DOCUMENTS

A. Listing of Documents does not limit responsibility of determining full extent of work required by these Contract Documents. Refer to the Consultant's, HVAC, Plumbing and Fire Protection, Electrical, Structural, Site Utility and all other drawings and other sections that types of and work of other trades with which work of this section must be coordinated

B. Except where modified by a specific notation to the contrary; it shall be understood that the indication and/or description of any item, in the drawings or specifications or both, carries with it the instruction to furnish and install the item, regardless of whether or not this instruction is explicitly stated as part of the indication or description.

C. Items referred to in singular number in Contract Documents shall be provided in quantities necessary to complete work.

D. Drawings are diagrammatic. They are not intended to be absolutely precise; they are not intended to specify every offset, fitting and component. The purpose of the document is to indicate systems concept, the main components of the systems, and the approximate geometric relationships. Based on the systems concept, the main components and the approximate geometrical relationships, the contractor shall provide all other components and materials necessary to make the systems fully complete and operational

E. Information and components shown on riser diagrams, but not shown on plans, and vice versa, shall apply and be provided as if expressly required on both

F. Data that may be furnished electronically by the Consultant (on compact disk, diskette, or otherwise) is diagrammatic. Such electronically furnished information is subject to the same limitation of precision as heretofore described. If furnished, such data is for convenience and generalized reference, and shall not be substitute for Consultant's sealed or stamped construction documents.

1.7 ELECTRIONIC MEDIA FILES

A. Construction drawings for this project have been prepared utilizing Autodesk software to produce two dimensional drawings.

B. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. All drawings and specifications will be provided in vector PDF format. Plans may be requested in AutoCAD DWG format. Under no circumstances will risers, details, diagrams or notes be released in DWG format. Release of three dimension/BIM electronic design information will be at Engineer's sole discretion unless Engineer's contract with Owner provides for specific conditions of such release.

C. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Release" form provided by Buro Happold.

D. The electronic contract documents can be used to assist in the preparation of shop drawings and as-built drawings however the electronic media files obtained from Buro Happold are for reference only. The information may not be used in whole or in part for any other project. They may not be relied upon for contractual purpose.

E. The drawings prepared for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.

F. The use of these CAD or BIM documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades, other prime contractors, and verification of space available for the installation.

G. The information is provided to expedite the project and assist the Contractor with no guarantee by Buro Happold as to the accuracy or correctness of the information provided. Buro Happold accepts no responsibility or liability for the Contractor's use of these documents.

1.8 REVIEW OF CONTRACT DOCUMENTS AND SITE

A. With the submission of his bid, Contractor shall give written notice to the Owner of any materials or apparatus believed inadequate or unsuitable, in violation of laws, ordinances, rules or regulations of Authorities having jurisdiction, and any necessary items of work omitted. In the absence of such written notice it is mutually agreed that the Contractor has included the cost of all required items in his proposal for a complete project.

B. Contractor shall acknowledge that he has examined the Plans, Specifications and Site, and from his own investigations he has satisfied himself as to the nature and location of the work; the general and local conditions, particularly those bearing upon transportation, disposal, handling and storage of materials; availability of labor, water, electric power, roads and uncertainties of weather; the conformation and condition of the ground; the character, quality and quantity of surface and subsurface materials to be encountered; the character of equipment and facilities needed preliminary to and during the execution of the work; all federal, state, county, township and municipal laws, ordinances and regulations particularly those relating to employment of labor, rates of wages, and construction methods; and all other matters which can in any way affect work or the cost thereof under this Contract. Any failure by the Contractor to acquaint himself with the available information concerning these conditions will not relieve him from the responsibility for estimating properly the difficulty or cost of successfully performing the work.

C. The location and elevation of the underground utilities, such as sewers, electrical power, water piping, steam and steam condensate return piping, conduit, etc., is as exact as can be determined from available information and its accuracy cannot be guaranteed. Exact location and elevation of these services shall be verified prior to excavation or installation of any portion of the work indicated. Exercise special care when excavating at or near the general location of underground utilities to avoid damage to the utility services. The Contractors is responsible to insure worker safety.

D. The contractor shall also acknowledge having been to the site and examined conditions under which work must be performed including preparatory work done under other Sections or other Contracts or by the Owner. Report conditions to the Consultant. Do not proceed until defects have been corrected and conditions are satisfactory. Commencement of work shall be construed as complete acceptance of existing conditions and preparatory work.

E. Owner assumes no responsibility for any understanding or representation made during or prior to the negotiation and execution of this Contract unless such understanding or representations are expressly stated in the Contract, and the Contract expressly provides that the responsibility, therefore, is assumed by the Owner.

1.9 DISCREPANCIES IN DOCUMENTS

A. Where Drawings or Specifications conflict or are unclear, advise the Consultant in writing before award of Contract. Otherwise, Consultant’s interpretation of the Contract documents shall be final, and no additional compensation shall be permitted due to discrepancies or ambiguousness thus resolved.

B. Where Drawings or Specifications do not coincide with manufacturer’s recommendations, or with applicable codes and standards, alert the Consultant in writing before installation. Otherwise, make changes in installed work as the Consultant requires within Contract Price.

C. If the required material, installation, or work can be interpreted differently from drawing to drawing, or between drawings and specification, this contractor shall provide material, installation, or work which is of the higher standard and price.

D. It is the requirement of these documents to have contractor provide systems and components that are fully complete and fully operational and fully suitable for intended use. There may be situations in the documents where insufficient information exists to precisely describe a certain component or subsystem, or the routing of the component or its coordination with other building elements. In cases such as this, where the contractor has failed to notify the Consultant of the situation in accordance with paragraph (A) above, the contractor shall provide specific component or subsystem with all parts necessary for the intended use, fully complete and operational, and installed in workmanlike manner either concealed or exposed per the design intent.

E. In cases covered by paragraph (D) above, where the contractor believes he needs the engineering guidance, he shall submit a sketch identifying his proposed solution and the Consultant shall review, note if necessary, and approve the sketch.

1.10 MODIFICATION IN LAYOUT

A. HVAC, Plumbing, Fire Protection, and Electrical Drawings are diagrammatic. They indicate general arrangements of mechanical and electrical systems and other work. They do not show all offsets required for coordination nor do they show exact routings and locations needed to coordinate with structure and other trades to meet the Consultant's requirements

B. In order to obtain the Consultant's desired aesthetics in spaces used by building occupants, in all such spaces, prior to installation of visible materials, finishes and equipment (including access panels, review Consultant's Drawings for desired locations and where not definitely indicated, request information from the Consultant.

C. Check Contract Drawings, as well as Shop Drawings, of all subcontractors to verify and coordinate spaces in which work of this section will be installed

D. Maintain maximum headroom at all locations. All piping, duct conduit, and associated components to be as tight to underside of structure as possible.

E. Make reasonable modifications in layout and components to prevent conflict with work of other trades and to coordinate according to Paragraphs A,B,C,and D above. Systems shall be run in an organized and rectilinear fashion.

F. Where conflicts or potential conflict exists and engineering guidance is desired, submit sketch of proposed resolution to the Consultant for review and approval

1.11 RFI'S

A. If the RFI is a request to resolve a conflict or an un-clarity, or a request for additional detail, Contractor's RFI shall include a sketch or equivalent description of Contractor's proposed solution, in accordance with paragraph 1.9(E) above

1.12 PROJECT COMMUNICATION

A. Communication and Submittals:

B. The specification references communication and submittal of information and documents by the Contractor to the Engineers of Record and CM or vice versa. In all cases such communication shall be submitted to the CM who will review it before forwarding to the relevant party for review and response.

C. If the information provided is not in conformance with the specification the CM shall return it to the relevant Contractor for re-submission.

D. The time taken for this process shall be factored into all work schedules and submissions.

1.13 MEASUREMENTS

A. Contractor shall base all his measurements, both horizontal and vertical from established benchmark. All work shall agree with these established lines and levels. He shall verify all measurements at site; and check the correctness of same as related to the work.

1.14 MATERIALS AND WORKMANSHIP

A. Materials shall be new, meet detailed requirements of the Contract Documents and be identifiable as being specified or substitute products.

B. Materials which do not conform to the requirements of the Contract Documents, are not equal to approved samples or are unsatisfactory or unsuited to the purpose for which they are intended, will be rejected.

C. All work shall be performed in the best and most workmanlike manner by tradesmen skilled in their respective trades and properly licensed.

D. All equipment shall be installed in accordance with the recommendation of the manufacturer.

E. Defective work, whether the result of poor workmanship, use of defective materials, damage through carelessness, or other cause shall be removed within ten (10) days after written notice is given by the Owner’s Representative and the work shall be re-executed by the Contractor. The fact that the Owner’s Representative may have previously overlooked such defective work shall not constitute total or partial acceptance of it.

F. In no case shall a Bidder base his bid on a class of material or workmanship less than that required by the contract documents nor the governing codes and ordinances.

1.15 CHECKING AND TESTING EQUIPMENT BY CONTRACTORS AND MANUFACTURER'S REPRESENTATIVE

A. All equipment shall be installed in strict accordance with manufacturer's instructions. During construction request supervisory assistance from equipment manufacturer's representatives so the equipment will be correctly installed. After installation, request the Owner’s Representative to inspect and see the equipment is in proper working order.

B. Manufacturer's representative shall review the overall system design relative to the proper application of his equipment in the particular system. He shall note conduit, wiring, control, location, and other relevant relationships, and furnish appurtenances necessary for satisfactory operation.

C. Before final payment is issued the following shall be complete:

D. The Contractor’s representative shall submit to the CM a signed statement certifying:

1. The equipment is properly installed and ready for operation
2. The owners maintenance representatives have been thoroughly trained
3. Maintenance and operation manuals issued and accepted by the Owner’s Representative.

1.16 TEMPORARY FACILITIES

A. Temporary Heating: Temporary heating shall be as specified in construction manager’s bid package. Contractor shall provide all means of temporary heating of the construction site and area impacted by the shutdown of the heating during the construction.

B. Temporary Light and Power: Provided under Division 26000.

C. All temporary facilities shall be removed at completion of project.

D. Temporary Water: Temporary water outlets shall be as listed in construction manager’s bid package.

1.17 SUBMITTALS

A. This paragraph supplements the requirements of Division 1 and any other general conditions.

B. Definitions:

1. Shop Drawings are information prepared by the Contractor to illustrate portions of the work in more detail than shown in Contract Documents.
2. Coordination Drawings are detailed, large scale layout Shop Drawings showing HVAC, Electrical, Plumbing and Fire protection work superimposed in order to identify conflicts and ensure inter-coordination of Mechanical, Electrical, Plumbing, Fire Protection, Structural and other work.

C. Submittal Cover Sheet

1. Shop drawing submittal for each product shall include the copy of following cover sheet completely filled out. Incomplete or incorrect cover sheet submittal shall constitute reason for rejection.
2. Shop drawings shall be submitted according to specification section with a separate cover sheet completed for each product, rather than one cover sheet for multiple products, whether or not supplied by one manufacturer or vendor.
3. In order to maintain the shop drawing review schedule described hereafter, it is important that all submittals include a completed submittal cover sheet for each type of equipment submitted. This requirement will be enforced by the engineer.

SHOP DRAWING COVER SHEET		
PROJECT CONTRACTOR		
DIVISION NO: SECTION NO:		
DESCRIPTION:		
CONTRACT DRAWING REFERENCE NO:		
EQUIPMENT TAG:		
SUBMISSION (CIRCLE ONE): I II III IV		
DATE:		
INFORMATION AND CHECKLIST	REPLY	COMMENTS
1. Contractor's Log # ID		
2. Name, address, and phone number of supplier		
3. Are all specified or scheduled items included and exactly match scheduled/specified items.	Yes No	
4. Is this item a substitution?	Yes No	
5. Are deviations clearly identified?	Yes No	
6. Does this equipment fit space shown on construction documents, coordination drawings, and actual field conditions?	Yes No	
7. Has support, erection, weights, and installation been coordinated with all trades?	Yes No	
8. Does the proposed installation void warranties and/or violate UL or code requirements?	Yes No	
9. Does this material/equipment add expense to any other trade or project costs?	Yes No	
10. Does equipment require interface with other trades? Lists divisions and specifics requiring coordination?	Yes No	
11. Is control interface coordinated?	Yes No	
12. List electrical characteristics (V/Ph/A)	Yes No	

Submittals procedure and format

4. Review submittal packages for compliance with Contract Documents and then submit to the Consultant for review. Submit legible vector PDF format drawings and product submittal information. Paper submittals and raster PDFs (information that is printed and then scanned) will be rejected. All shop drawings will be returned by electronic means.
5. Shop Drawings showing layouts of systems shall contain sufficient plans, elevations, sections, details and schematics to describe work clearly. They shall be ¼”=1’-0” scale unless otherwise specified. Sheet metal shop drawings shall be 3/8”=1’-0” and shall indicate work of other sections where physical clearances are critical and where interferences are possible. Provide larger scale details as necessary. Shop drawings shall show elements of Consultant’s reflected ceiling plan, exposed ductwork, walls, partitions, diffusers, registers, grilles, fire dampers, sleeves and other aspects of construction as necessary coordination.
6. ALL RATED WALLS AND ASSEMBLIES AS DEPICTED ON ARCHITECTURAL DRAWINGS SHALL BE HIGHLIGHTED ON THE SHEET METAL DRAWINGS FOR APPROPRIATE COORDINATION.
7. Shop Drawings showing manufacturer’s product data shall contain detailed dimensional drawings, accurate and complete description of materials of construction, manufacturer’s published performance characteristics and capacity ratings (performance data alone, is not acceptable), electrical requirements, wiring diagrams, field installation diagrams and manufacturer’s performance test on equipment. Drawings shall clearly indicate location (terminal block or wire number), voltage and function for all field terminations, and other information necessary to demonstrate compliance with all requirements of Contract Documents.
8. Provide shop drawings submittals showing details of piping and ductwork connections to all equipment. If connection details are not submitted, and the connections are found installed incorrectly in the field, this contractor shall reinstall them within the original contract price.
9. Shop drawings shall clearly indicate compliance with each and every requirement of specifications and drawings.

    a. Contractor shall list all specification paragraphs that have been complied with
    b. Contractor shall also list all specification paragraphs that are not being complied with but address the features or installation of the submitted product together with a reason compliance with the requirement is not possible or not within the scope of their contract.
    c. To document compliance with this submission requirement contractor may simply submit the contract specification with each paragraph marked with compliance, non-compliance together with a reason compliance is not possible, and non-applicability to submitted product.
    d. Engineer reserves the right to summarily reject any submittal omitting this summary of compliance.

10. Consultant's review of shop drawing information presented in plan will generally exclude review of piping and ductwork sizes of risers passing through or heading to or from other floors.
11. Consultant's review of Contractor's riser diagrams is primarily for vertical distribution sizes and distribution topology. Consultant shall not be estopped from giving direction and binding feedback to contractor for horizontal distribution, offsets, location of risers in plan, equipment sizes, equipment quantities, and equipment locations when such items are reviewed within the context of other submissions.

D. Acceptable Manufacturers: The Consultant's mechanical/electrical design for each product is based on the single manufacturer listed in the schedule or shown on the drawings. In Part 2 of the specifications certain Alternate Manufacturers are listed as being acceptable. These are acceptable only if, as a minimum, they:

1. Meet all performance criteria listed in the schedules and outlined in the specifications. For example, to be acceptable, an air handling unit must deliver equal CFM against equal external static pressure using equal or less horsepower, equal or better coil thermal performance, equal or better acoustic performance as the air handler listed in schedules.
2. Have identical operating characteristics to those called for in the specifications. For example, a two stroke diesel generator will not be acceptable if a four stroke is specified.
3. Fit within the available space it was designed for, including space for maintenance and component removal, with no modification to either space or product. Clearances to walls, ceilings and other equipment will be least equal to those shown on the design drawings. The fact that a manufacturer's name appears as acceptable shall not be taken to mean that the Consultants has determined that the manufacturer's products will fit within the available space. This determination is solely the responsibility of the contractor.
4. For rooftop mounted equipment and for equipment mounted where structural matters are a consideration, the products must have a weight no greater than listed in the schedule or specifications.
5. Products must adhere to all Consultant's considerations including, but not limited to: being of same color as the product scheduled or specified, fitting within Consultant's enclosures and details, and for diffusers, lighting and plumbing fixtures – being the same size and physical appearance as scheduled or specified products.
6. The proposed substitution shall meet performance and quality of scheduled equipment, whether it requires additional accessories or not.
7. There is no increase in Contract Sum and this Contractor shall pay for any additional work required by other trades as a result of the substitution.
8. Submit all equipment sound power and pressure level for review and compliance.

E. Required Use of Acceptable Manufacturers on his Project: Substitution of products other than those of the Acceptable Manufacturers specified herein shall not be made. Only the specified items or the comparable product by one of the specified Alternate Manufacturers shall be submitted. Products by other manufacturers shall not be used on this project.

F. Deviations:

1. Concerning deviations other than substitutions, proposed deviations from Contract Documents shall be requested individually in writing whether deviations result from field conditions, standard shop practice or other cause. Submit letter with transmittal of shop drawings, which flags deviation to the attention of the Consultants.
2. Without letters flagging the deviation to the Consultants, it is possible that the Consultants may not notice such deviation or may not realize its ramifications. Therefore, if such letters are not submitted to the Consultants, the contractor shall hold the Consultants and his consultants harmless for any adverse consequences resulting from the deviations being implemented. This shall apply regardless of whether the Consultants has reviewed or approved shop drawings containing the deviation, and will be strictly enforced.
3. Approval of proposed deviations, if any, will be made at discretion of Consultants.
4. Any of the approved deviations shall be deemed acceptable to this Contractor with no change in contract sum, unless the Consultant also receives a written notice to the contrary.

G. Submittal Notations: Submittals will be returned from the Consultants marked as illustrated below:

1. In no case do any actions relieve the contractor from compliance with the contract documents, authorize changes in price or schedule, or otherwise mitigate the contractor's responsibilities as outlined in the contract documents or in the submittal review stamp.
2. No exceptions taken: "Reviewed and found generally acceptable. No further submittal required if notations are complied with."
3. Make corrections noted: "Reviewed and found generally acceptable. Minor deviations may be noted. No further submittal required if notations are complied with."
4. Revise and resubmit: "Submittal contains deviations which must be corrected and confirmed by a new submittal."
5. Rejected: "Submittal is incorrect to such an extent that the material is unacceptable, or in incomplete to such an extent that a review cannot be made. Resubmit in accordance with requirements of the Contract Documents."

H. Responsibility:

1. Intent of Submittal review is to check for capacity, rating, and certain construction features. Contractor shall ensure that the work meets the requirements of Contract Documents regarding information that pertains to fabrication processes or means, methods, techniques, sequences and procedures of construction; and for coordination of work of this or other Sections. Work shall comply with submittals marked "REVIEWED" to the extent they agree with the Contract Documents. Submittal review shall not diminish responsibility under this Contract for dimensional coordination, quantities, installation, wiring, supports and access for service, nor shop drawing errors or deviations from requirements of Contract Documents. The Consultant's noting of some errors while overlooking the others will not excuse the contractor from proceeding in error. Contract Documents are not limited, waived nor superseded in any way by review.
2. INFORM SUBCONTRACTORS, MANUFACTURERS, SUPPLIERS, ETC. OF SCOPE AND LIMITED NATURE OF REVIEW PROCESS AND ENFORCE COMPLIANCE WITH CONTRACT DOCUMENTS.

I. Schedule: Incorporate shop drawing review period into construction schedule so that Work is not delayed. Contractor shall assume full responsibility for delays caused by not incorporating the following review time requirements into his project schedule. Working days listed reference the time in Engineer's office. It does not include transmittal time or review time of Contractor or the Consultant. Allow at least 10 working days, exclusive of transmittal time, for review each time shop drawing is submitted or resubmitted with the exception that 20 working days, exclusive of transmittal time, are required for the following:

1. HVAC temperature control submittals.
2. HVAC balancing report.
3. Coordination Drawings.
4. If more than five shop drawings of a single trade are received in one calendar week.

J. List of Proposed Equipment and Materials:

1. Within four weeks of Award of Contract and before ordering materials or equipment, submit complete list of materials and equipment and indicate manufacturer's name, addresses and telephone numbers. No consideration will be given to partial lists submitted out of sequence.

2. If the List of Materials and Equipment is not received within the prescribed time limit, provide the first-named manufacturer for all material and equipment on this project.

1.18 EQUIPMENT SUPPLIER'S INSPECTION

A. The following equipment shall not be placed in operation until a competent installation and service representative of the manufacturer has inspected the installation and certified that the equipment is properly installed, adjusted and lubricated; that preliminary operating instructions have been given; and that the equipment is ready for operation:

1. Base Mounted Pumps
2. Heat Rejection Equipment, including but not limited to:

    a. Dry coolers

    b. Condensing units.

3. Fire Seal Systems
4. Seismic Restraints and Equipment Bracing
5. Air Handling Units
6. Dedicated Outdoor Air Units

B. Contractor shall arrange for and obtain supplier's on-site inspection(s) at proper time(s) to assure each phase of equipment installation and/or connection is in accordance with the manufacturer's instructions.

C. Submit copies of start-up reports to the Engineer and include copies IN THE Project Close-Out and Owner's Operation and Maintenance Manuals.

1.19 COORDINATION DRAWINGS:

A. A single set of coordination drawings shall be mutually prepared by all mechanical and electrical trades.

B. The initiation of these drawings begins with Sheet Metal Subcontractor.

C. The Sheet Metal Subcontractor shall prepare a complete set of electronic background drawings at scale not less than 3/8" equals 1'-0", showing structure and other information as needed for coordination. He shall show sheet metal layout thereon. These will be Coordination Drawings.

D. Each of the mechanical, electrical and other specialty trade shall add its work to these background drawings with appropriate elevations and grid dimensions. Specialty trade information is require for fan rooms and mechanical rooms, horizontal exits from duct shafts, crossovers, and for spaces in and above ceilings where congestion of work may occur such as corridors, and even entire floors. Drawings shall indicate horizontal and vertical dimensions, to avoid interference with structural framing, ceilings, partitions, and other services.

E. Each specialty trade shall sign and date each coordination drawing. Return drawing to the Sheet Metal Subcontractor, who shall route them sequentially to all specialty trades.

F. Where conflicts occur with placement of materials of various trades, the Sheet Metal Subcontractor will be responsible to coordinate the available space to accommodate all trades. Any resulting adjustments shall be initialed and dated by specialty trade. The Sheet Metal Subcontractor shall then final date and sign each drawing. If he cannot resolve conflicts, the decision of the General Contractor/Construction Manager shall be final.

G. A Subcontractor who fails to promptly review and incorporate his work on the drawings shall assume full responsibility of any installation conflicts affecting his work and of any schedule ramifications.

H. Sheet Metal Subcontractor shall make prints of all coordination drawings. Fabrication shall not start until such transparencies of completed coordination drawings are received by the Consultant/Engineer and have been reviewed and approved.

I. The review of coordination drawings shall not diminish responsibility under this Contract for final coordination of installation and maintenance clearances of all systems and equipment with the other trades, structural and other work.

J. After review:

1. After review of coordination drawings, the method used to resolve interferences not previously identified shall be as in “MODIFICATIONS IN LAYOUT” above.
2. All changes to reviewed coordination drawings shall be in writing by the Consultants/Engineer prior to start of work in affected area.

K. Distribution of Coordination Drawings:

1. The Sheet Metal Subcontractor shall provide the following distribution of documents:

    a. One sepia (reproducible) of each Coordination Drawing to each specialty trade and affected Contractor for their use.
    b. One reproducible of each Coordination drawing to Owner.
    c. One sepia (reproducible) of each coordination drawing to the General Contractor/Construction Manager.
    d. The above documents can be submitted as electronic media upon agreement of all parties.

L. ALL FIREWALLS AND SMOKE PARTITIONS SHALL BE HIGHLIGHTED ON COORDINATION DRAWINGS FOR APPROPRIATE COORDINATION.

M. The main paths of egress and for equipment removal from main mechanical and electrical rooms must be clearly shown on coordination drawings.

N. Coordination Drawings shall include, but not limited to:

1. Plumbing systems, piping and equipment.
2. HVAC piping, systems and equipment.
3. Control systems.
4. Electrical distribution, systems and equipment.
5. Lighting systems and fixtures.
6. Sheet metal work, components and accessories, costs and boxes in terminals, etc.
7. Fire protection and sprinkler system, piping and heads.
8. Structural.

9. Electrical Equipment Room layouts.
10. Environmental Rooms and associated refrigeration/heating systems.
11. Partition/room layout.
12. Ceiling tile and grid.
13. Access panels.
14. Smoke and fire dampers.
15. Roof drain piping.
16. Major electrical conduit runs, panel-boards, feeder conduit and racks of branch conduit.
17. Above ceiling miscellaneous metal.
18. Heat tracing of piping.
19. Minimum access space requirements for all equipment for both installation and maintenance.

1.20 COORDINATION BUILDING INFORMATION MODEL (BIM)

A. General Requirements:

1. The General Contractor shall appoint a BIM Coordination Manager to prepare a BIM Execution Plan developed specifically for the project, and based on the Computer Integrated Construction (CIC) Research Program's BIM Planning procedures. The BIM Execution Plan will establish the protocols, expected levels of development, and authorized uses of Building Information Models on this Project and assigns specific responsibility for the development of each Model Element to a defined Level.

B. Services to be modelled:

1. All piping (above ½") and all equipment shall be modelled based on the proposed submitted products. The model may be used for production of shop drawings.

C. Clash Detection:

1. Perform three-dimensional component conflict analysis as part of coordination process with all other trades, including but not limited for Mechanical, Plumbing, Fire Protection and Fire Alarm. Resolve component conflicts prior to submittal of shop drawings. Indicate where conflict resolution requires modification of design requirements by Construction Manager.

D. 3D Assets:

1. The contractor shall hand over all digital data files related to the BIM execution plan at the end of the construction process, including all, but not limited to the shop drawings and as built conditions.

1.21 REGULATIONS, CODES, PERMITS, AND FEES

A. Conform to all rules, regulations, standards, ordinances and laws of local, state, and Federal governments and other authorities that have legal jurisdiction over the site.

B. Prior to commencement of work, notify State and applicable authorities as required and submit all of the applicable notifications for construction, operation and demolition. Secure required permits and inspections from any of the authorities having jurisdiction, for this work and pay for all fees required for permits, inspections and review, including special agency construction.

C. Include all utility and local building department charges for providing temporary and permanent water, sewer, and gas services to buildings.

D. Provide Owner, Owner's Representative and Inspectors from any of the authorities / agencies having jurisdiction access to work at all times.

E. Contractor shall be responsible for all law violations caused by the work under this Division. Notify Construction Manager in writing when a discrepancy occurs between code requirements and work shown on drawings and resolve matter before proceeding with work.

F. When requirements cited in this specification conflict with each other or with Contract Documents, most stringent shall govern work. Consultants may relax this requirement when such relaxation does not violate ruling of authorities that have jurisdiction. Approval for such relaxation shall be obtained in writing.

G. Make corrections in the work as required by the Owner's Representative or Inspector to pass local regulations.

H. Contractor shall deliver to the Construction Manager any and all certificates of inspections, permits, and approvals. Contractor shall submit final inspection certificates signed by governing authorities to the Owner.

I. Make all necessary submissions to the Department of Environmental Protection, Bureau of Air Resources and Management, Department of Labor and Industry and other agencies having jurisdiction. Pay all required fees for review, registration and sign off.

1.22 ACOUSTICAL COMPLIANCE FOR AIR HANDLING EQUIPMENT, PUMPS, FANS, COOLING TOWERS, AND EXHAUST SYSTEMS

A. Contractor shall provide provision to bring on board, at contractor cost and no cost to the owner, the service of an Acoustical consultant for evaluation of submitted units (outdoor equipment or indoor equipment) and system exposed to ambient surrounding and noise level criteria set forth by the local code and law.

B. Contractor shall certify noise level compliance and provide potential alteration(s) in the submissions of the equipment for noise level compliance installation.

C. Contractor confirm that the installation of any equipment in communication with outdoor shall comply with Local Law and regulations.

D. Contractor shall provide ambient noise level testing and report to establish the existing noise level at the site prior to new construction. Contractor shall also provide noise level testing upon completion of the installation to warranty the level pre code compliance.

E. LEED for Schools noise requirements shall be complied with on school projects.

1.23 OPERATING AND MAINTENANCE MANUALS

A. Obtain at time of purchase of equipment, three copies of operation and maintenance manuals for all items. Assemble literature in coordinated "D" ring notebooks. All information shall also be provided in electronic PDF format. Divide the manuals into three sections or books as follows:

B. System General Description and Information. Section shall include a general description of the systems used and contain names and addresses of manufacturers and local representatives who stock or furnish or repair parts for items or equipment. List of all major equipment as installed and include model number, capacities, nameplate data and manufacturer's location and purchase order information. Include in the manuals, parts catalogs for each item of equipment furnished with the components identified by number for replacement ordering. This section shall also include:

1. Letters from manufacturers certifying their supervision of equipment installation and startup procedures as required.
2. Machinery vibration test reports.
3. Certificates of piping system cleaning and chemical treatment.
4. Equipment test certificates.

C. Operation, Start-up and Shutdown Procedures. Section shall include directions for and sequence of operation for each item of the Mechanical and Electrical systems; e.g., air handling units, boilers, chillers, domestic water pump, generator, etc. Sequence list shall list valves, switches, and other devices used to start, stop and control system. Include detailed approved control diagrams and flow diagrams of each air and hydronic system. Include approved valve directory showing each valve number, location of each valve, and equipment or fixture controlled by valve. Provide a motorized and manual damper charts organized on a room and by system basis, detailing and damper number.

D. Provide a step-by-step write-up and video of the operation, start-up and shut down procedures for all major equipment.

E. Problems, Solutions and Troubleshooting. Section shall include detailed procedures to be followed in case of equipment or system malfunctions. Include manufacturer's printed troubleshooting procedures into the operating manual for reference.

F. Preventative Maintenance. Section shall include preventative maintenance requirements and schedule for each piece of equipment. This shall include lubrication instructions detailing type of lubricant, amount and intervals recommended by manufacturer for each item of equipment. A lubrication chart listing each item of equipment, all points of lubrication, lubrication type and lubrication schedule.. Include additional instructions necessary for implementation of preventative lubrication program. In addition provide additional preventative maintenance procedures concerning routine maintenance, draining of coils, belt sizes, types and adjustment tension etc. required in order to properly operate equipment.

G. Diagrams and Charts.

1. One copy of each valve chart, damper chart, and lubrication chart shall be mounted under glass and installed at locations to be selected by the Owner.
2. Provide control diagrams, for each air and hydronic system, suitably framed, with glass front. Diagrams shall show complete equipment, controls, model numbers, etc., marked to correspond to identification on equipment. Locate as directed by Owner.
3. Air and water flow diagrams.

H. In addition to the above provide all information in electronic media.

I. Furnish three copies of manuals to the Consultant for approval and distribution to Owner. Deliver manuals no less than 30 days prior to project close-out or 10 days prior to commissioning whichever is sooner.

1.24 FIELD ADJUSTMENT TO AIR HANDLING EQUIPMENT, PUMPS, AND FANS

A. Contractor shall be responsible for changing or adjusting belts, drives, pulleys, motors, impellers, etc., as required, by adjustment for acoustic performance, and by balancing company to achieve the desired air and water delivery by all air handling equipment and pumps.

1.25 RECORD DRAWINGS (AS-BUILTS)

A. As work progresses and for duration of Contract, maintain current complete and separate sets of prints of Contract drawings at job site. Record work completed and all changes from original Contract Drawings clearly and accurately including work installed as a modification or addition to original design. Include actual location of existing utilities if they differ from design documents. Record valve tags as they are installed. In addition, take photographs of concealed work to include, but not limited to:

1. All concealed equipment in gypsum board ceilings.
2. All shafts.
3. All concealed piping routes in walls, floors, underground, or above inaccessible ceilings.
4. Ducting concealed in walls, underground, or above inaccessible ceilings.
5. Volume dampers, fire and smoke dampers, and access panels; both exposed and concealed.
6. All underground waste and soil lines inside the building.

B. Underground utility services, both inside and outside of buildings, shall be dimensioned from permanent structures or benchmark. Utility services outside of buildings shall also show depth of burial with reference to the finished ground floor elevation.

C. All “main air” pneumatic control piping routing locations shall be shown on record drawings.

D. Drawings shall show record condition of details, sections, riser diagrams, control changes and correction to schedules. Schedules shall show actual manufacturer and make and model numbers of final equipment installation. All elements shall be dimensioned from grid lines or benchmarks and all elevations shall be noted. Construction notes (such as component numbers, conflict notes, etc.) shall be removed and the drawings shall clearly be noted in the title block as being as-built drawings.

E. At the completion of the project, prepare a complete set of record drawings, showing all systems actually installed, as well as electronic files on latest CAD version.

F. The design tracings will be made available for Contractor’s copying, at his expense, into reproducible to serve as background drawings. The quantity of design tracings, which are made available shall in no way be interpreted as setting a limit to the number of drawings necessary to show required information. Contractor’s professional draftsperson shall transfer changes to record files and then submit the electronic files and three sets of prints to the Consultant for comments as to compliance with this section.

G. The record set reproducible, as corrected and recorded by the Contractor, shall be submitted to the Owner's Representative for approval prior to authorization for final payment. Record drawings shall be certified as to their correctness by the signature of the Contractor, and shall be stamped or otherwise identified as record drawings. THE CONSULTANT WILL NOT CERTIFY THE ACCURACY OF THE RECORD DRAWINGS – THIS IS THE SOLE RESPONSIBILITY OF THE CONTRACTOR.

H. Each trade shall submit record set for approval by the building department in a form acceptable to the department, when required by the jurisdiction. Such drawing format size changes, and supplemental information required for the submittal are the requirement of the contractor.

1.26 COOPERATION BETWEEN TRADES

A. Cooperate with all other Divisions performing work on this project as necessary to achieve a complete neatly fitted installation for each condition. Consult the Drawings and Specifications to determine nature and extent of work specified in other Divisions that adjoins or attaches to the work of this Division. Confer with other Divisions at the site to coordinate this work with theirs in view of job conditions to the end that interferences may be eliminated and that maximum head room and clearance may be obtained. In the event that interferences develop, the Owner's Representative's decision will be final as to which Division shall relocate its work, and no additional compensation will be allowed for the moving of piping, ductwork, conduit, or equipment, to clear such interferences. Provide templates, information, and instructions to other divisions to properly locate holes and openings to be cut or provided

B. For Testing and Balancing of the system, ensure full co-ordination between the Testing and Balancing subcontractor and all other Trades to achieve access to all system components, including leaving wall/ceiling sections down for access. HVAC Contractor shall be responsible for pre-balancing checks and check sheet and responsibilities outlined in Section 15990.

C. Ensure full co-ordination between controls subcontractor and Testing and Balancing subcontractor to ensure the system is commissioned in accordance with the complete requirements of the complete contract documents.

1.27 HOIST, RIGGING, TRANSPORTATION AND SCAFFOLDING

A. Provide all scaffolding, staging, cribbing, tackle hoist and rigging necessary for placing all materials and equipment in their proper places in the Project. All temporary work shall be removed from the premises when its use is no longer required.

1.28 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment in its original package to prevent damage or entrance of foreign matter. Perform all handling and shipping in accordance with manufacturer's recommendations. Provide protective coverings during construction.

B. Identify materials and equipment delivered to Site to permit check against approved materials list, reviewed Shop Drawings.

C. Completely cover motors and other moving machinery to protect from dirt and water during construction.

D. Cap all openings in pipe and ductwork daily to protect against entry by foreign matter.

E. Protect premises and Work of other Divisions from damage arising out of installation of Work of this Division.

F. Perform Work in manner precluding unnecessary fire hazard.

G. All ductwork shall be delivered to site with all ends and openings capped with minimum of heavy gauge polyethylene sheeting taped all around to prevent ingress of moisture, dust, debris, etc.

H. Protect from loss or damage. Replace lost or damaged materials and equipment with new at no increase in Contract Sum. Protect from damage, water, dust, etc., material, equipment and apparatus provided under this Division, both in storage and installed, until Notice of Completion has been filed. Provide temporary storage facilities for material and equipment. Material, equipment or apparatus damaged because of improper storage or protection will be rejected. Remove from Site and provide new, duplicate material, equipment or apparatus in replacement of that rejected.

I. All stock piled conduit and piping shall be placed on dunnage, and protected from weather and from entry of foreign material. All stored materials and equipment shall be carefully inspected prior to installation and replaced with new material or equipment if found to be damaged, corroded, etc.

1.29 GUARANTEE AND 24 HOUR SERVICE

A. Guarantee the Work of this section for one year following the date of Substantial Completion. If the equipment is used for ventilation, temporary heat, etc. prior to initial beneficial occupancy by the Owner, the bid price shall include an extended period of warranty covering the one year of occupancy starting from the initial date of beneficial occupancy by the Owner. The guarantee shall repair or replace defective materials, equipment, workmanship and installation that develop within this period, promptly and to the Consultant’s satisfaction and correct damage caused in making necessary repairs and replacements under guarantee within Contract Price.

B. In addition to guarantee requirements of Division 1 and of Paragraph A above, obtain written equipment and material warranties offered in manufacturer’s published data without exclusion or limitation, in Owner’s name.

C. Replace material and equipment that require excessive service during guarantee period as defined and as directed by the Consultant.

D. Provide 24 hour service beginning on the date of substantial completion and lasting until the termination of guarantee period. Service shall be at no cost to Owner. Service can be provided by this Contractor or a separate service organization. Choice of service organization shall be subject to the Consultant and Owner approval. Submit name and phone number that will be answered on a 24 hour basis each day of the week, for the duration of the service.

E. Submit copies of equipment and material warranties to Consultants before final payment.

F. At end of guarantee period, transfer manufacturer’s equipment and warranties still in force to Owner.

G. This paragraph shall not be interpreted to limit Owner's rights under applicable codes and laws under this Contract.

H. Part 2 Paragraphs of the Specification sections may specify warranty requirements that exceed those of this Paragraph.

I. Use of systems provided under this Section for temporary services and facilities shall not constitute Final Acceptance of work nor beneficial use by Owner, and shall not institute guarantee period.

J. Provide manufacturer's engineering and technical staff at site to analyze and rectify problems that develop during guarantee period immediately. If problems cannot be rectified immediately to Owner's satisfaction, advise the Consultant in writing, describe efforts to rectify situation, and provide analysis of cause of problem. Consultants will suggest course of action.

PART 2 PRODUCTS

2.1 GENERAL

A. Equipment and materials shall be as described in the respective Sections of Division 230000 and Division 260000 and as shown.

2.2 MATERIALS

A. Equipment specified by manufacturer's number shall include all accessories, controls, etc., listed in catalog as standard with equipment. Furnish optional or additional accessories as specified. And or/as required to provide a fully operational installation.

B. Equipment, material damaged during transportation, installation, operation is considered as totally damaged. Replace with new. Payment for this equipment shall not be approved. Variance from this permitted only with written acceptance.

C. All items of materials in each category of equipment shall be of one manufacturer.

D. Material and Equipment–General Requirements:

1. New.
2. Testing agency labeled or with other identification wherever standards have been established.
3. Owner's Representative reserves right to reject items not in accordance with Specification either before or after installation.
4. Comprised to render complete and operable systems; provide additional items needed to complete installation to realized design.
5. Compatible with space allocated. Modifications necessary to adjust items to space limitations at Contractor's expense.
6. Installed fully operating and without objectionable noise or vibration.

2.3 FLAME-SPREAD AND SMOKE-DEVELOPED PROPERTIES OF MATERIALS

A. All materials and adhesives used throughout the mechanical systems shall have a flame spread rating not over 25 without evidence of continued combustion and with a smoke-developed rating not higher than 50. Materials include but not limited to are insulation, acoustical lining, filter, ducts, flexible connections, jackets or coverings regardless of kind, etc. If such materials are to be applied with adhesives and the adhesives used shall have a flame-spread rating not over 25 and a smoke developed rating not higher than 50.

B. "Flame Spread Rating" and "Smoke Developed Rating" shall be as determined by the "method of test of surface burning characteristics of building materials, NFPA no. 244, ASTM E84, Underwriters' Laboratories, Inc., Standard." Such materials are listed in the Underwriters' Laboratories, Inc., "Building Materials List" under the heading "Hazard Classification (Fire)."

PART 3 EXECUTION

3.1 COMMISSIONING OF EQUIPMENT AND SYSTEMS

A. General

1. Completion of startup and commissioning shall be accomplished as a prerequisite for substantial completion and shall be completed for each phase of construction.
2. Operate and maintain systems and equipment until final acceptance by Owner.
3. All guarantees and warranties shall not begin until final acceptance of the systems and equipment by the Owner. Acceptance requires, at a minimum complete systems and commissioning.
4. The Owner maintains the right to have access to the entire project site to develop his own operational procedures.

B. Comprehensive Work Plan and Reporting

1. Provide detailed, methodical, scheduled, start up and commissioning procedures and execution of same and every system and piece of equipment provided.
2. Attend start up and commissioning meetings on a regular basis, as directed by the General Contractor or Construction Manager.
3. Develop and provide a written work plan with detailed procedures for this work and submit, using shop drawing submittal procedure, within 6 weeks of the contract award. The work plan shall include provisions for an integrated start up plan and schedule. The plan and schedule shall identify tasks, start and completion dates, critical path items, interface requirements with other trades and major equipment start up, as minimum requirements of the plan. The plan and schedule shall clearly identify work in each construction phase, as well.
4. The purpose of this work plan is to provide for smooth, quick, and efficient start up and commissioning of systems and equipment and for a smooth transition to turn the complete, correctly operating building over to the Owner, at each phase of construction.
5. The Owner and the Consultant will have input to and be part of approval process for startup and commissioning plan.
6. Develop and submit for approval a specific start up, check out and sign off form for every piece of major equipment.

7. Develop and submit for approval a specific start up, check out and sign off form for every piece of major system.
8. Systems shall be operated under actual or simulated full load conditions. Identify the operating conditions in the work plan.
9. Work plan shall incorporate the below specified “Demonstration of Successful Operation”
10. The Consultant/Owner may check the completed and commissioned installation either sequentially as different parts are completed, and/or when the entire installation is complete, at sole option of the Consultant/Owner.
11. Each contractor shall arrange that an officer of his contracting company shall certify that each and every system has been tested. At the conclusion of the tests, this contractor shall submit a letter and enclosed commissioning forms signed by the officer stating:
12. That he is the officer of the company.
13. That he certifies that the specified testing of the systems has been performed by the company (give the name and dates of system testing).
14. The results of testing as compared to specified performance, listing the name, title, and company affiliation of all those witnessing and performing these tests.

C. Commissioning

1. Commission equipment and systems in accordance with the approved work plan, completing the startup, check out and sign off forms for each piece of equipment and each system.
2. Provide qualified personnel, equipment, apparatus and services for startup and testing of equipment and systems, to obtain the performance shown in schedules, as specified or on commissioning forms, and as required by codes, standards, regulations and authorities having jurisdiction including Municipal Inspectors, Owners and Consultants.
3. Start up and testing procedures as may be outlined in various mechanical and electrical sections of the specifications are the minimum effort required for the project. Contractor shall use any additional procedures he feels will be necessary to properly start up and test the systems and equipment actually installed on the job at no additional cost to the Owner.
4. Provide capacity and performance of equipment by field testing. Install thermowells and gauge connections and, at no additional cost to Owner, equipment and instruments required for testing.
5. Qualified representative of equipment manufacturer shall be present at test.
6. For each piece of equipment, copy nameplate data and include with the letter and start up, check out and sign off forms referred to above.
7. Do not cover or conceal work before testing and inspection and obtaining approval.
8. Leaks, damage and defects discovered or resulting from startup and testing shall be repaired or replaced by this contract to like-new condition with acceptable materials. Tests shall be continued until system operates without adjustments or repairs.

D. Demonstration of Successful Operation: After all components and every system has been completely commissioned, provide a two week, 24 hour per day fully functional automatic operation period of all systems simultaneously. This shall be successfully concluded before systems are accepted by the Owner.

3.2 SPECIAL RESPONSIBILITIES:

A. Cooperate and coordinate with work of other Sections in executing work of this Section.

1. Perform work such that progress of entire project including work of other Sections shall not be interfered with or delayed.

2. Provide information as requested on items furnished under this Section which shall be installed under other Sections.
3. Obtain detailed installation information from manufacturers of equipment provided under this section.
4. Obtain final roughing dimensions or other information needed for complete installation of items furnished under other Sections or by Owner.
5. Keep fully informed as to shape, size and position of openings required for material or equipment to be provided under this and other Sections. Give full information so that openings required by work of this Section may be coordinated with other work and other openings and may be provided for in advance. In case of failure to provide sufficient information on proper time, provide cutting and patching or have same done, at own expense and to full satisfaction of Consultants.
6. Provide information as requested as to sizes, number and locations of housekeeping pads necessary for floor mounted vibrating and rotating equipment provided under this Section.
7. Notify Consultants of location and extent of existing piping, conduit, ductwork and equipment that interferes with new construction. In coordination with and with approval of Consultants, relocate piping, ductwork and equipment to permit new work to be provided as required by Contract Documents. Remove non-functioning and abandoned piping, ductwork and equipment as directed by Consultants. Dispose of or store items as requested by Consultants.

B. Installation Only Items

1. Where this contractor is required to install items which it does not purchase, it shall coordinate delivery and be responsible for their unloading from delivery vehicles and for their safe handling and field storage up to time of installation. This trade shall be responsible for:
2. Any necessary field assembly and internal connections, as well as mounting in place of the items, including the purchase and installation of all dunnage supporting members and fastenings necessary to adapt to Consultant's and structural conditions.
3. Their connection to building systems including the purchase and installation of all terminating fittings necessary to adapt and connect them to the building systems.
4. This contractor shall carefully examine such items upon delivery. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of work of this contractor will be considered only if presented in writing within one week of their date of delivery. Unless such claims have been submitted this contractor shall be fully responsible for the complete reconditioning or replacement of the damaged items.

C. Maintenance of equipment and systems: Maintain equipment and systems until Final Acceptance. Ensure adequate protection of equipment and material during delivery, storage, installation and shutdown and during delays pending final test of systems and equipment because of seasonal conditions.

D. Use of premises: Use of premises shall be restricted as directed by the Consultant and as required below:

1. Remove and dispose of dirt and debris, and keep premises clean. During progress of work, remove equipment and unused material. Put building and premises in neat and clean condition, and do cleaning and washing required to provide acceptable appearance and operation of equipment, to satisfaction of the Consultant.

2. Store materials in a manner that will maintain an orderly clean appearance. If stored on-site in open or unprotected areas, all equipment and material shall be kept off the ground by means of pallets of racks and covered with tarpaulins.
3. Do not interfere with function of existing sewers and water and gas mains, electrical or mechanical systems and services. Extreme care shall be observed to prevent debris from entering pipe, ductwork and equipment. Confer with the Consultant as to the disruption of services or other utilities due to testing, connection of new work to existing. Interruption of services shall be performed at time of day or night deemed by Owner to provide minimal interference with normal operation. Obtain Owner's approval of the method proposed for minimizing service interruption.

E. Surveys and Measurements:

1. Base measurements, both horizontal and vertical, on reference points established by Contractor and be responsible for correct laying out of work.
2. In event of discrepancy between actual measurements and those indicated, notify the Consultant in writing and do not proceed with work until written instructions have been issued by the Consultant.

F. Fireproofing:

1. Clip, hangers, clamps, supports and other attachments to surfaces to be fireproofed shall be installed, insofar as possible prior to start of spray fiber work.
2. Ducts, piping and other items which would interfere with proper application of fireproofing shall be installed after completion of spray fiber work.
3. Patching and repairing of fireproofing due to cutting or damaging to fireproofing during course of work specified under this section shall be shall be performed by installer of fireproofing and paid for by the trade responsible for damage and shall not constitute grounds for an extra to Owner.

G. Temporary Utilities:

H. Refer to Division 1 regarding requirements.

1. Coordinate work under this Section with progress of construction so that permanent heating system will be ready for temporary heating if permitted by the Consultant as soon as the building is closed in.
2. Provide and direct labor required for attendance, operation and final restoration of permanent heating system if used for temporary heating purposes. Continuous direct attendance shall be provided whenever permanent system is in operation prior to acceptance of permanent heating system by Owner.

I. Air bound Systems: If, after the plant is in operation, any piping systems, coils or other apparatus are stratified or air bound (by vacuum or pressure), they shall be re-piped with new approved and necessary fittings, air vents, or vacuum breakers at no extra cost. If connections are concealed in furring, floors or ceilings, this trade shall bear the cost of tearing up and refinishing construction and finish, leaving same in as good condition as before it was disturbed.

J. Miscellaneous: Unload materials and equipment delivered to site. Pay cost for rigging, hoisting, lowering and moving electrical equipment on and around site, in building or on roof.

3.3 MATERIAL AND WORKMANSHIP

A. Work shall be neat and rectilinear. Ductwork, piping, conduit, etc. shall run concealed except in mechanical rooms and areas where no hung ceiling exists. Install material and equipment to comply with manufacturers. Recommended Requirements. Rough Work will be rejected. Installation shall operate safely and without leakage, undue wear, noise, vibration, corrosion or water hammer. Work shall be properly and effectively protected, and pipe and duct openings shall be temporarily closed to prevent obstruction and damage before completion.

B. Except as specified otherwise, material and equipment shall be new. Provide supplies, appliances and connections necessary for complete and operational installation. Provide components required or recommended by OSHA and applicable NFPA documents.

C. Finish of materials, components and equipment shall be as approved by the Consultant and shall be resistant to corrosion and weather as necessary.

D. Owner will not be responsible for material and equipment before testing, commissioning, and acceptance.

3.4 CONTINUITY OF SERVICES

A. Do not interrupt existing services without Owner's approval.

B. Schedule interruptions in advance, according to Owner's instructions. Submit, in writing, with request for interruption, methods proposed to minimize length of interruption.

C. Interruptions shall be scheduled at such times of day and work so that they have minimal impact to Owner's operations.

D. Subcontractor shall coordinate any shutdowns of existing systems as follows:

1. Give proper notice to Owner when making shutdowns; a minimum of fourteen full days are required.
2. Minimize shutdowns of any system.
3. Provide temporary services where required and perform shutdown and tie-ins at a time convenient to Owner.
4. Subcontractor shall be responsible for completing and filing Owner's shutdown notice questionnaire.
5. Perform required survey and inspection work required by the notice for shutdown.

E. Include premium time work associated with interruption of services and/or shutdown as necessary to avoid disruption to Owner's operations.

3.5 ANCHORS AND INSERTS:

A. Inserts shall be iron or steel of type to receive machine bolt head or nut after installation. Insert shall permit adjustment of bolt in one horizontal direction and shall develop strength of bolt when installed in properly cured concrete.

B. Provide anchors as necessary for attachment of equipment support and hangers.

3.6 ESCUTCHEONS

A. Install escutcheons around exposed pipe passing through finished floor, floor, wall, or ceiling. Escutcheons shall be heavy cast brass, chromium plated, adjustable, and of sufficient outside diameter to cover sleeve opening and shall fit snugly around pipe and flush against floor or wall surface. Escutcheon plates shall be provided on pipes at fixtures and shall be polished chrome plated. Plated steel escutcheon plates are not acceptable. Sample escutcheon plates shall be submitted to the Consultant for approval prior to installation.

3.7 CORE DRILLING

A. Core drilling is to be avoided.

B. Set sleeves prior to installation of structure for passage of pipes, conduits, ducts, etc.

C. Where core drilling is unavoidable, or required by renovation projects, locate all required openings prior to coring and submit to the Consultant for review.

D. Coordinate openings with General Contractor/Construction Manager and all other trades.

E. Responsibility for core drilling shall be as per the scope boundaries identified in Division 1.

F. Do not disturb existing systems.

G. Thoroughly investigate existing conditions in vicinity of required opening prior to coring.

3.8 CUTTING AND PATCHING:

A. Complete cutting and patching in accordance with Division 1, Cutting and Patching Article, and as follows.

B. Provide all sleeves, core drilling, carpentry, cutting and patching required for proper installation of material and equipment specified in this Division.

C. Do not cut or drill structural members without written approval of Owner’s Representative and structural engineer.

D. No cutting or patching should be done without first receiving the Consultant’s and Structural Engineer’s written approval.

E. Any damage caused by cutting and patching shall be restored to the original condition as required by the Consultant.

3.9 VIBRATION CONTROL:

A. Coordinate with Division 1.

B. Design criteria for all the Work of Division 230000 shall be as specified in 230548.

3.10 WATERPROOF CONSTRUCTION:

A. Maintain waterproof integrity of penetrations of materials intended to be waterproof. Provide flashing at exterior wall and roof penetrations. Caulk watertight penetrations of foundation walls and floors. Provide membrane clamps at penetrations of waterproof membranes.

B. Provide galvanized sheet metal weather protection canopies, hoods or enclosures over all out-of-doors equipment, the operation or maintenance of which would be impaired by rainwater. This requirement applies to damper operators and bearing, damper motors, controls, and instruments. See other paragraphs in this Division for application of this requirement to motors, drive, ducts, and fans.

3.11 RESTORATION OF DAMAGE:

A. Repair or replace, as directed by the Consultant and/or Owner's Representative, materials and parts of premises which become damaged as result of installation of Work of this Division. Remove replaced parts from premises.

3.12 LINTELS

A. Where openings break into an already completed wall as a result of a failure to set sleeves or provide openings during erection of the wall, the Contractor shall provide lintels as required for the support of building construction above the inserted item.

B. Lintels shall be structural steel angles, channels or tees of proper size and sections for the supported load; submit to the Consultant with supporting calculations for approval prior to the installation.

C. Where new openings are required in an existing wall; coordinate opening size, location and lintel type with structural engineer.

3.13 ROOF OPENINGS AND CURBS

A. Roof openings where required shall be coordinated with the other affected trades and all flashing and patching shall be as per details indicated on the Consultant's plans.

B. TOOLS AND EQUIPMENT

1. Furnish all tools and equipment necessary for the proper installation, protection and upkeep of the Work.

3.14 ADJUSTMENTS

A. Preliminary Operation:

1. Operate any portion of installation for Owner's convenience if so requested by Construction Manager. Such operation does not constitute acceptance of Work as complete. Cost of utilities, such as gas and electrical power, will be borne by Owner if Owner requests operation.

B. Startup Service:

1. Prior to startup, ensure that systems are ready, including checking the following: proper equipment rotation, proper wiring, auxiliary connections, lubrications, venting fan balance, controls and installed and properly set relief and safety valves.

C. Start and operate all systems. Provide services of factory trained technicians for startup of major equipment and systems including chillers, boilers, pumps, air handling units, etc.

D. Adjusting:

1. Adjust all equipment and system components as shown or as otherwise required to result in intended system operation.
2. Thereafter, as a result of system operation or as directed by Owner’s Representative, make readjustments as necessary to refine performance and to effect complete system "tune-up".
3. After completion of testing and adjustment, operate the different systems and equipment under normal working conditions for 72 hours continuously and show specified performance.
4. If, in the opinion of the Consultant, performance of equipment or systems is not in accordance with specifications or submitted data, alter or replace equipment at no increase in Contract Sum. The Contractor, at his option, may order tests from an independent approved laboratory to prove compliance. All such tests shall be at no increase in Contract Sum. Repeat process as often as required. If the reason for unsatisfactory operation is design errors all additional cost for corrective measures will be reimbursed to the contractor.
5. At completion of Work, provide written certification that all systems are functioning properly without defects.

E. Noise:

1. Cooperate in reducing any objectionable noise or vibration caused by mechanical systems to the extent of adjustments to specified and installed equipment and appurtenances.
2. Cooperate in adjustment of mechanical systems and terminal devices, as directed by Owner’s Representative, to obtain specified acoustic properties.
3. Completely correct noise problems caused by failure to make installation in accordance with Contract Documents, including labor and materials required as a result of such failure, at no increase in Contract Sum. Includes refinish walls, floors etc.

3.15 INSTALLATION OF EQUIPMENT

A. Use printed descriptions, specifications and recommendations of manufacturers as a guide for installation of Work.

B. Assemble equipment required to be field assembled under the direct supervision of the manufacturers' agent. Prior to the final acceptance submit letters from the manufacturers that this has been done.

C. Avoid interference with structure and with work of other trades, preserving adequate headroom and clearing doors and passageways, to the satisfaction of the Consultant and in accordance with code requirements. Installation shall permit clearance for access to equipment for repair, servicing and replacement.

D. Install equipment so as to properly distribute equipment loads on building structural members provided for equipment support under other Sections. Roof mounted equipment shall be installed and supported on structural steel provided under other Sections.

E. Provide suspended platforms, strap hangers, brackets, shelves, stands or legs as necessary for floor, wall of ceiling mounting of equipment as required.

F. Provide steel supports and hardware for proper installation of hangers, anchors, guides, etc.

G. Provide cuts, weights, and other pertinent data required for proper coordination of equipment support provisions and installations.

H. Structural steel and hardware shall conform to Standard specifications of ASTM; use of steel and hardware shall conform to requirements of Section V of Code of Practice of American Institute of Steel Construction.

I. Verify site conditions and dimensions of equipment to ensure access for proper installation of equipment without disassembly, which will void warrantee. Report in writing to the Consultant, prior to purchase or shipment of equipment involved, on conditions which may prevent proper installation.

3.16 PAINTING

A. Equipment installed shall have shop coat of non-lead gray paint. Hangers and supports shall have one coat of non-lead primer. Machinery such as pumps, fans, etc., shall be stenciled with equipment name. Stencil shall be at least 6” high for large equipment, 2” high for small equipment. Finish painting, including painting of various piping and duct systems, shall be done under other Sections.

B. Paint all outside exposed equipment and equipment supports with two coats of weather resistant enamel.

C. Provide heat resistant paint for hot piping, equipment and materials.

D. Properly prepare Work under this Division to be finish painted under Division 9.

E. Refer to standard paint colors for all Mechanical, Electrical equipment inside the Building.

3.17 LUBRICATION

A. Lubricate all equipment at completion of Work. Furnish Owner with a written lubrication schedule for all equipment as specified in Division 1 and Division 23000.

3.18 SELECTIVE DEMOLITION

A. Refer to all drawings for general description of areas requiring demolition.

B. Refer to General Contractor's/Construction Manager's Instructions for all existing equipment and materials that shall remain the property of the Owner.

C. Items of value which are not directed to be returned to the Owner shall become the property of the Contractor. Storage or sale of items on the project site is prohibited.

D. Protection: Ensure the safe passage of persons in and around building during demolition. Prevent injury to persons and damage to property. Provide adequate shoring and bracing to prevent collapse. Immediately repair damaged property to the condition before being damaged. Take effective measures to prevent windblown dust.

E. Utilities: Maintain all utilities except those requiring removal or relocation. Keep utilities in service and protect from damage. Do not interrupt utilities serving used areas without first obtaining permission from the utility company and the Owner. Provide temporary services as required.

3.19 FINAL JOBSITE OBSERVATION

A. As the work nears completion, the Contractor is to review the requirements of the Contract Documents, inspect the work and inform all parties involved of the work to be corrected or completed before the project can be deemed substantially complete.

B. When the Project is substantially complete, In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation. Notify the Owner's Representative in writing of this fact, listing any items of Work remaining incomplete, the reason therefore, and the anticipated date that all remaining work will be completed. The Contractor shall inform the certification that the project is complete and ready for a final punch, the Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.

C. It is understood that if the Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Engineers additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

D. The Contractor shall carry out their own final inspection and satisfy the Work.

E. The Owner's Representative reserves the right to cancel and reschedule the inspection in the event considerable more work remains to be completed or corrected than indicated in the written request for inspection.

F. All items not completed or found not complying with drawings or specifications by the Owner's Representative will be identified in their inspection report.

G. Correct all items on inspection report. Make the correction and initial and date each item on the report after corrections have been completed.

H. Include the fee for all local inspections.

3.20 INSTRUCTING THE OWNER'S REPRESENTATIVES

A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.

B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.

C. The Owner has the option to video tape all instructions. Coordinate schedule of instructions to facilitate this recording.

D. The instructions shall include:

1. Explanation of all system flow diagrams.
2. Explanation of all air handling systems.
3. Temperature control system operation including calibration, adjustment and proper operating conditions of all sensors.
4. Maintenance of equipment.
5. Smoke control systems.
6. Start-up procedures for all major equipment.
7. Explanation of seasonal system changes.
8. Description of emergency system operation.

3.21 PROJECT CLOSE-OUT PROCEDURE

A. General

1. The requirements of this section are in addition to and supplement the requirements outlined in Division 1.
2. It shall be each contractor's responsibility to personally hand-deliver all of the required project close-out checklist items and to obtain Owner's authorized representative(s) signed receipt on all items requiring Owner sign-off.

B. Project Close-Out Checklist

1. Review requirements of each section of the specifications and submit for approval to Consultants the sign-off forms which shall become the project close-out checklist. These, at a minimum, shall include the following information shown in attached Project Closeout Checklist Example. The Consultants and/or Owner may incorporate additional specific items to the following checklist which shall become part of project requirements.

C. Close-Out Checklist Example:

PROJECT CLOSE-OUT			
PROJECT:			
DIVISION NO:			
CONTRACTOR:			
ITEM1	DATES		OWNER'S SIGN-OFF
	COMPLETED	RECEIVED BY	

		OWNER	
Permits			
City and County Inspection			
Manufacturer's Warranties			
State Fire Rating Data			
Copy of Final Shop Drawings			
List and Possession of Spare Parts			
Pressure Tests			
Equipment Tests Required by Specs			
O&M Manuals			
Record Documents			
Coordination Drawings			
Sanitization Reports			
Commissioning Reports/Letters/Forms			
On Site Training Complete			
Protective Device Settings			
Valve Tags and Charts			
Final ATC Installation Drawings			
Insurance Underwriters Approvals			
Final Punch List (Initialed by contractor that items are complete)			
Building Certificate of Occupancy			
24 Hr Phone No. for Service During Guarantee Period.			
1 Provide separate line item for each specified item (do not group items).			

READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

In order to prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

Penetrations fire sealed and labeled in accordance with specifications.

All air handling units operating and balanced.

All fans shall be operating and balanced.

All pumps and chillers operating and balanced.

All miscellaneous mechanical systems (unit heaters, fan coil units, cabinet heaters, etc.) operating.

All temperature control systems operating, programmed and calibrated.

Pipe insulation complete, pipes labeled and valves tagged.

Fire damper and fire/smoke damper access doors labeled in accordance with specifications.

Accepted by:

Contractor _____

By _____ Date _____

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Engineer so that the final observation can be scheduled.

It is understood that if the Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

END OF SECTION 230500

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

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 general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Rotor: Random-wound, squirrel cage.

F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

G. Temperature Rise: Match insulation rating.

H. Insulation: Class F.

I. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.5 SINGLE-PHASE MOTORS

A. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

B. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

C. Motors 1/20 HP and Smaller: Shaded-pole type.

D. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 EXECUTION (Not Applicable)

END OF SECTION 230513

SECTION 230516 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

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:

1. Pipe loops and swing connections.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.

B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

PART 3 EXECUTION

3.1 PIPE LOOP AND SWING CONNECTION INSTALLATION

A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.

C. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

END OF SECTION 230516

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

1.1 SLEEVES

A. Cast-Iron Pipe Sleeves: Cast iron or ductile iron, with plain ends and integral waterstop collar.

B. Steel Pipe Sleeves: Anti-corrosion coated, with plain ends and integral waterstop collar.

C. Galvanized-Steel Sheet Pipe Sleeves: Round tube closed with welded longitudinal joint.

1.2 SLEEVE-SEAL SYSTEMS

A. Field-assembled, modular sealing-element unit for filling annular space between piping and sleeve.

1.3 SLEEVE-SEAL FITTINGS

A. Manufactured plastic, sleeve-type, plastic or rubber waterstop assembly, made for imbedding in concrete slab or wall.

1.4 GROUT

A. Nonshrink, factory packaged.

1.5 SILICONE SEALANTS

A. Silicone, S, NS, 25, NT: Single-component, non-sag, plus 25 percent and minus 25 percent movement capability, non-traffic-use, neutral-curing silicone joint sealant.

1.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.

1.7 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Concrete Slabs above Grade:

1. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves .
2. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.

B. Interior Partitions:

1. Piping Smaller Than NPS 6: PVC-pipe sleeves.
2. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 230517

SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING

1.1 SUMMARY

A. Section includes:

1. Escutcheons.
2. Floor plates.

1.2 PRODUCTS

A. Escutcheons for New Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One-piece deep pattern.
2. Insulated Piping: One-piece steel with polished chrome-plated finish.
3. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece steel with polished chrome-plated finish.
4. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
5. Bare Piping in Unfinished Service Spaces: One-piece steel with polished, chrome-plated finish.
6. Bare Piping in Equipment Rooms: One-piece steel with polished, chrome-plated finish.

B. Floor Plates: Split-plate stamped steel with concealed hinge.

END OF SECTION 230518

SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

1.1 PRODUCTS

A. Filled-System Thermometers:

1. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:

B. Liquid-in-Glass Thermometers:

1. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:

C. Duct-Thermometer Mounting Brackets: Flanged bracket, for attachment to air duct.

D. Thermowells:

1. Material for Use with Copper Tubing: CNR or CUNI.
2. Material for Use with Steel Piping: CRES.

E. Pressure Gages:

1. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

F. Test Plugs: Test-station fitting made for insertion in piping tee fitting.

G. Test-Plug Kits: Furnish one test-plug kit(s) containing two thermometer(s), one pressure gage and adapter, and carrying case.

H. Sight Flow Indicators:

1. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator.

I. Flowmeters:

1. Orifice Flowmeters:

J. Thermal-Energy Meters:

1. Ultrasonic, Thermal-Energy Meters:

END OF SECTION 230519

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

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:

1. Metal pipe hangers and supports.
2. Thermal-hanger shield inserts.
3. Equipment supports.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
3. Nonmetallic Coatings: Plastic coated, or epoxy powder-coated.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.3 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psiminimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psiminimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.5 MATERIALS

A. Aluminum: ASTM B 221.

B. Carbon Steel: ASTM A 1011/A 1011M.

C. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; galvanized.

D. Stainless Steel: ASTM A 240/A 240M.

E. Threaded Rods: Continuously threaded. Zinc-plated or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.

F. Grout: ASTM C 1107/C 1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 EXECUTION

3.1 APPLICATION

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

C. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

D. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

E. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

F. Install lateral bracing with pipe hangers and supports to prevent swaying.

G. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

H. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

I. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

J. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Use thermal-hanger shield insert with clamp sized to match OD of insert.
    b. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    b. NPS 4: 12 inches long and 0.06 inch thick.
    c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
    d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
    e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

3. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
4. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and 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 welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and attachments for general service applications.

F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal-hanger shield inserts for insulated piping and tubing.

END OF SECTION 230529

SECTION 230548.13 - VIBRATION CONTROLS FOR HVAC

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:

1. Elastomeric isolation pads.
2. Restrained-spring isolators.
3. Elastomeric hangers.
4. Spring hangers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device type required.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 PRODUCTS

2.1 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads: .

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Mason Industries, Inc.

2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.

4. Pad Material: Oil and water resistant with elastomeric properties.
5. Surface Pattern: Waffle pattern.

2.2 RESTRAINED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:

1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

    a. Mason Industries, Inc.

2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.

    a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
    b. Top plate with threaded mounting holes.
    c. Internal leveling bolt that acts as blocking during installation.

3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.3 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Mason Industries, Inc. Type HD

2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.4 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Mason Industries, Inc. Type 30N

2. Minimum Static Deflection: 1in

3. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
8. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
9. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 VIBRATION CONTROL DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

C. Device Schedule:

1. Dedicated Outside Air Unit Fans to be internally individually isolated with Mason Industries Type 30N, rated for a minimum 1" static deflection.
2. VRF Condensing units to be provided with mixed spring and neoprene vibration isolation similar to Mason Industries Type 30N, rated for a minimum 1" static deflection.
3. VRF Fan Coil Units to be provided with mixed spring and neoprene vibration isolation similar to Mason Industries Type 30N, rated for a minimum 1" static deflection.

4. Exhaust fans to be provided with mixed spring and neoprene vibration isolation similar to Mason Industries Type 30N, rated for a minimum 1" static deflection.
5. Electric Unit Heaters to be provided with double deflection neoprene hangars similar to Mason Industries Type HD.

END OF SECTION 230548.13

SECTION 230553 **-** IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

1.1 QUALITY ASSURANCE

A. Quality Standard for Piping Identification: ASME A13.1.

1.2 PRODUCTS

A. Equipment Labels: Metal.

B. Warning Signs and Labels: 1/8 inch thick with .

C. Pipe Labels: Self-adhesive.

D. Duct Labels: thick with adhesive.

E. Stencils: Brass.

F. Valve Tags: stainless steel, 0.025-inch minimum thickness.

G. Warning Tags: ; brass grommet and wire fasteners.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

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:

1. Balancing Air Systems:

a. Constant-volume air systems.
b. Variable-air-volume systems.
c. Multizone systems.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An entity engaged to perform TAB Work.

1.4 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by NEBB.
1. TAB Field Supervisor: Employee of the TAB contractor and certified by NEBB.
2. TAB Technician: Employee of the TAB contractor and who is certified by NEBB as a TAB technician.

B. TAB Report Forms: Use standard TAB contractor's forms approved by Construction Manager.

C. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

E. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.5 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.6 COORDINATION

A. Notice: Provide [seven] <Insert number> days' advance notice for each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on [air] [and] [water] distribution systems have been satisfactorily completed.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 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. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in [Section 233113 "Metal Ducts"] [Section 233116 "Nonmetal Ducts"] and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine system pumps to ensure absence of entrained air in the suction piping.

L. Examine operating safety interlocks and controls on HVAC equipment.

M. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:

1. Permanent electrical-power wiring is complete.
2. Automatic temperature-control systems are operational.
3. Equipment and duct access doors are securely closed.
4. Balance, smoke, and fire dampers are open.
5. Isolating and balancing valves are open and control valves are operational.
6. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
7. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in and in this Section.

1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:

a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
b. Measure static pressure directly at the fan outlet or through the flexible connection.
c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
6. 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.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of submain and branch ducts.

a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure 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.
3. Measure total system airflow. Adjust to within indicated airflow.
4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.

    a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

    a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
8. Record final fan-performance data.

3.7 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. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.8 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

3.9 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. 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 and at each incremental stage.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:

1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Air pressure drop.
4. Inlet steam pressure.

D. 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.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.10 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.
3. Heating-Water Flow Rate: Plus or minus 10 percent.
4. Cooling-Water Flow Rate: Plus or minus 10 percent.

3.11 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare [weekly] [biweekly] [monthly] <Insert time interval> progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.12 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Fan curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. Architect's name and address.

6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:

    a. Unit identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.
    f. Unit arrangement and class.
    g. Discharge arrangement.
    h. Sheave make, size in inches, and bore.
    i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
    j. Number, make, and size of belts.
    k. Number, type, and size of filters.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

a. Total air flow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Filter static-pressure differential in inches wg.
f. Preheat-coil static-pressure differential in inches wg.
g. Cooling-coil static-pressure differential in inches wg.
h. Heating-coil static-pressure differential in inches wg.
i. Outdoor airflow in cfm.
j. Return airflow in cfm.
k. Outdoor-air damper position.
l. Return-air damper position.
m. Vortex damper position.

F. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Coil identification.
d. Capacity in Btu/h.
e. Number of stages.
f. Connected volts, phase, and hertz.
g. Rated amperage.
h. Air flow rate in cfm.
i. Face area in sq. ft..
j. Minimum face velocity in fpm.

2. Test Data (Indicated and Actual Values):

a. Heat output in Btu/h.
b. Air flow rate in cfm.
c. Air velocity in fpm.
d. Entering-air temperature in deg F.
e. Leaving-air temperature in deg F.
f. Voltage at each connection.
g. Amperage for each phase.

G. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

    a. System identification.
    b. Location.
    c. Make and type.
    d. Model number and size.
    e. Manufacturer's serial number.
    f. Arrangement and class.
    g. Sheave make, size in inches, and bore.
    h. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Motor Data:

    a. Motor make, and frame type and size.
    b. Horsepower and rpm.
    c. Volts, phase, and hertz.
    d. Full-load amperage and service factor.
    e. Sheave make, size in inches, and bore.
    f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
    g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

    a. Total airflow rate in cfm.
    b. Total system static pressure in inches wg.
    c. Fan rpm.
    d. Discharge static pressure in inches wg.
    e. Suction static pressure in inches wg.

H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

    a. System and air-handling-unit number.
    b. Location and zone.
    c. Traverse air temperature in deg F.
    d. Duct static pressure in inches wg.
    e. Duct size in inches.
    f. Duct area in sq. ft..
    g. Indicated air flow rate in cfm.
    h. Indicated velocity in fpm.
    i. Actual air flow rate in cfm.
    j. Actual average velocity in fpm.
    k. Barometric pressure in psig.

I. Air-Terminal-Device Reports:

1. Unit Data:

    a. System and air-handling unit identification.

b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft..

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm.
b. Air velocity in fpm.
c. Preliminary air flow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final air flow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

J. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

a. System and air-handling-unit identification.
b. Location and zone.
c. Room or riser served.
d. Coil make and size.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm.
b. Entering-air temperature in deg F.
c. Leaving-air temperature in deg F.

3.13 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:

a. Measure airflow of at least [10] <Insert number> percent of air outlets.
b. Measure water flow of at least [5] <Insert number> percent of terminals.
c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
d. Verify that balancing devices are marked with final balance position.
e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Construction Manager.
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Construction Manager.
3. Construction Manager shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

END OF SECTION 230593

SECTION 230713 - DUCT INSULATION

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 insulating the following duct services:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.

1. Ductwork Mockups:

a. One 10-foot section each of rectangular and round straight duct.
b. One each of a 90-degree mitered round and rectangular elbow, and one each of a 90-degree radius round and rectangular elbow.
c. One rectangular branch takeoff and one round branch takeoff from a rectangular duct. One round tee fitting.
d. One rectangular and round transition fitting.
e. Four support hangers for round and rectangular ductwork.
f. Each type of damper and specialty.

2. Notify Design Teamseven days in advance of dates and times when mockups will be constructed.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, . Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Johns Manville; Microlite.
    b. Knauf Insulation; Friendly Feel Duct Wrap.
    c. Manson Insulation Inc.; Alley Wrap.
    d. Owens Corning; SOFTR All-Service Duct Wrap.

2.2 FIELD-APPLIED JACKETS

A. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

2.3 TAPES

A. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Width: 2 inches.
2. Thickness: 3.7 mils.
3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Provide vapor barrier on all insulation for outdoor air, and supply air duct. Seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic or tape.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at [2 inches] [4 inches] o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Section 078413 "Penetration Firestopping"irestopping and fire-resistive joint sealers.

C. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.

2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.6 FINISHES

A. Insulation with Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

    a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

3.7 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.

3.8 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Supply-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.

B. Outdoor-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.

END OF SECTION 230713

SECTION 230719 - HVAC PIPING INSULATION

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 insulating the following HVAC piping systems:

1. Condensate drain piping, indoors.
2. Chilled-water piping, indoors.
3. Condenser-water piping, indoors when used for water-side economizer or for condensate control.
4. Heating hot-water piping, indoors.
5. Refrigerant suction and hot-gas piping, indoors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
2. Detail removable insulation at piping specialties.

1.4 QUALITY ASSURANCE

A. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.

1. Piping Mockups:

a. One 10-foot section of NPS 2 straight pipe.
b. One each of a 90-degree threaded, welded, and flanged elbow.
c. One each of a threaded, welded, and flanged tee fitting.
d. Four support hangers including hanger shield and insert.

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

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Aeroflex USA, Inc.; Aerocel.
b. Armacell LLC; AP Armaflex.
c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Aeroflex USA, Inc.; Aeroseal.
b. Armacell LLC; Armaflex 520 Adhesive.
c. K-Flex USA; R-373 Contact Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

EXECUTION

2.3 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

2.4 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

2.5 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Vapor barrier is required on all pipes containing chilled water, condensate, or refrigerant, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at [2 inches] [4 inches] o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

2.6 PENETRATIONS

A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

C. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

2.7 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

2.8 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

2.9 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

C. Do not field paint aluminum or stainless-steel jackets.

2.10 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 1 inch thick.

B. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 1-1/2 inch thick.
b. Provide rigid external jacket on all refrigerant piping visible from occupied spaces.

END OF SECTION 230719

SECTION 230800 - COMMISSIONING OF HVAC

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 commissioning process requirements for the following HVAC&R systems, assemblies, and equipment:

1. Energy supply systems, including generator oil supply.
2. Cooling generation systems, including direct-expansion systems.
3. Distribution systems, including air distribution (heating and cooling) systems exhaust systems air-handling units.
4. Terminal and packaged units, including energy recovery units, unit ventilators unit heaters fan-coil units electric heating packaged units.
5. Vibration and sound systems, including sound attenuation vibration isolation devices.
6. Controls and instrumentation, including BAS energy monitoring and control system.
7. Systems testing and balancing verification, including domestic hot-water circulating systems supply-air systems return-air systems exhaust-air systems.
8. Specialty Industrial Process Exhaust Systems

B. Related Requirements:

1. Section 019113 "General Commissioning Requirements" for general commissioning process requirements and Commissioning Coordinator responsibilities.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. DDC: Direct digital controls.

C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.

D. "Systems," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

E. TAB: Testing, adjusting, and balancing.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [BAS] [and] [HVAC&R] Testing Technician.

B. Construction Checklists: See related Sections for technical requirements for the following construction checklists:

1. Vibration and seismic controls for HVAC&R piping and equipment.
2. Instrumentation and control for HVAC&R.
3. Refrigerant piping.
4. Metal ducts and accessories.
5. Fans.
6. Particulate air filtration.
7. Air-handling units.
8. Computer-room air conditioners.
9. Air Handling Units
10. Variable Refrigerant Flow (VRF) Systems
11. Specialty Industrial Process Exhaust Systems

1.5 QUALITY ASSURANCE

A. BAS Testing Technician Qualifications: Technicians to perform BAS construction checklist verification tests, construction checklist verification test demonstrations, commissioning tests, and commissioning test demonstrations shall have the following minimum qualifications:

1. Journey-level or equivalent skill level with knowledge of BAS, HVAC&R, electrical concepts, and building operations.
2. Minimum [three years'] <Insert time> experience installing, servicing, and operating systems manufactured by approved manufacturer.
3. International Society of Automation (ISA) Certified Control Systems Technician (CCST) Level I.

B. HVAC&R Testing Technician Qualifications: Technicians to perform HVAC&R construction checklist verification tests, construction checklist verification test demonstrations, commissioning tests, and commissioning test demonstrations shall have the following minimum qualifications:

1. Journey-level or equivalent skill level. Vocational School four-year program graduate or an Associates degree in mechanical systems, air conditioning, or similar field. Degree may be offset by three years' experience in servicing mechanical systems in the HVAC industry. Generally, required knowledge includes HVAC&R systems, electrical concepts, building operations, and application and use of tools and instrumentation to measure performance of HVAC&R equipment, assemblies, and systems.
2. Minimum [three years'] <Insert time> experience installing, servicing, and operating systems manufactured by approved manufacturer.
3. One of the following:

    a. National Environmental Balancing Bureau (NEBB) Certified Testing, Adjusting, and Balancing Technician.
    b. Associated Air Balance Council (AABC) Certified Test and Balance Technician.
    c. Owner retains the right to waive NEBB or AABC Certification.

C. Testing Equipment and Instrumentation Quality and Calibration: For test equipment and instrumentation required to perform HVAC&R commissioning work, perform the following:

1. Submit test equipment and instrumentation list. For each equipment or instrument, identify the following:

    a. Equipment/instrument identification number.
    b. Planned commissioning application or use.
    c. Manufacturer, make, model, and serial number.
    d. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.

2. Test equipment and instrumentation shall meet the following criteria:

    a. Capable of testing and measuring performance within the specified acceptance criteria.
    b. Be calibrated at the manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
    c. Be maintained in good repair and operating condition throughout the duration of use on this Project.
    d. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

D. Proprietary Test Instrumentation and Tools:

1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the commissioning process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, perform the following:

    a. Submit proprietary instrumentation and tools list. For each instrument or tool, identify the following:

        1) Instrument or tool identification number.
        2) Equipment schedule designation of equipment for which the instrument or tool is required.
        3) Manufacturer, make, model, and serial number.
        4) Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.

    b. Include a separate list of proprietary test instrumentation and tools in the operation and maintenance manuals.
    c. HVAC&R proprietary test instrumentation and tools become the property of Owner at the time of Substantial Completion.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 GENERAL TESTING REQUIREMENTS

A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents and approved Shop Drawings and submittals.

B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents and approved Shop Drawings and submittals, and that pretest set points have been recorded.

C. Certify that TAB procedures have been completed and that TAB reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested according to approved test procedures (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions to verify compliance with acceptance criteria.

F. Test systems, assemblies, subsystems, equipment, and components operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and response according to acceptance criteria.

G. Construction Checklists: Prepare and submit detailed construction checklists for HVAC&R systems, subsystems, equipment, and components.

1. Contributors to the development of construction checklists shall include, but are not limited to, the following:

a. HVAC&R systems and equipment installers.
b. TAB technicians.
c. HVAC&R instrumentation and controls installers.

H. Perform tests using design conditions, whenever possible.

1. Simulated conditions may, with approval of Architect, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by Commissioning Coordinator and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.
2. Commissioning test procedures may direct that set points be altered when simulating conditions is impractical.

3. Commissioning test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.

I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to Owner. After deficiencies are resolved, reschedule tests.

J. If seasonal testing is specified, complete appropriate initial performance tests and documentation and schedule seasonal tests.

K. Coordinate schedule with, and perform the following activities at the direction of, Commissioning Coordinator.

L. Comply with construction checklist requirements, including material verification, installation checks, start-up, and performance tests requirements specified in Sections specifying HVAC systems and equipment.

M. Provide technicians, instrumentation, tools, and equipment to complete and document the following:

1. Performance tests.
2. Demonstration of a sample of performance tests.
3. Commissioning tests.
4. Commissioning test demonstrations.

3.2 TAB COMMISSIONING TESTS

A. TAB Verification:

1. Prerequisites: Completion of "Examination" Article requirements and correction of deficiencies, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
2. Completion of "Preparation" Article requirements for preparation of a TAB plan that includes strategies and step-by-step procedures, and system-readiness checks and reports, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
3. Scope: HVAC&R air systems and hydronic piping systems.
4. Purpose: Differential flow relationships intended to maintain air pressurization differentials between the various areas of Project.
5. Conditions of the Test:

    a. Commissioning Test Demonstration Sampling Rate: As specified in "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
    b. Systems operating in full heating mode[with minimum outside-air volume].
    c. Systems operating in full cooling mode[with minimum outside-air volume].
    d. For measurements at air-handling units with economizer controls; systems operating in economizer mode with 100 percent outside air.

6. Acceptance Criteria:

    a. Under all conditions, rechecked measurements comply with "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
    b. Additionally, no rechecked measurement shall differ from measurements documented in the final report by more than two times the tolerances allowed.

c. Under all conditions, where the Contract Documents indicate a differential in airflow between supply and exhaust and/or return in a space, the differential relationship shall be maintained.

3.3 HEATING CONTROL SYSTEM COMMISSIONING TESTS

A. Heating-Water Supply Temperature Control:

1. Prerequisites: Installation verification of the following:

a. Startup of [boiler] <Insert boiler designations> [steam to hot-water converter] <Insert converter designations> <Insert prime heating-water equipment>.
b. Startup of heating-water pump(s) <Insert pump designations>.
c. TAB of heating-water flow and pressure.
d. Input Device: Heating-water supply temperature; [thermostat] [thermistor temperature sensor] [resistance temperature sensor] <Insert device designations>.
e. Output Device: Control valve <Insert device designation>.
f. Display the following at the operator's workstation:

1) Heating-water supply temperature.
2) Heating-water supply temperature set point.
3) Control-valve position.

2. Scope: Heating-water system.
3. Purpose: Control of heating-water supply temperature at input device <Insert device designation>.
4. Conditions of the Test:

a. Minimum heating-water flow.
b. Midrange Heating-Water Flow: [50 to 60] <Insert number(s)> percent of maximum.
c. Maximum heating-water flow.

5. Acceptance Criteria: Under all conditions, heating-water supply temperature is within plus or minus [2.0 deg F] <Insert temperature> of set point.

B. Heating-Water Supply Temperature Reset:

1. Prerequisites: Installation verification of the following:

a. Startup of [boiler] <Insert boiler designations> [steam to hot-water converter] <Insert converter designations> <Insert prime heating-water equipment>.
b. Startup of heating-water pump(s) <Insert pump designations>.
c. TAB of heating-water flow and pressure.
d. Input Device: Heating-water supply temperature; [thermostat] [thermistor temperature sensor] [resistance temperature sensor] <Insert device designations>.
e. Input Device: Outdoor-air temperature; [electric, outdoor-air-reset controller] [outdoor-air sensor].
f. Output Device: Control valve <Insert device designations>.
g. Display the following at the operator's workstation:

1) Outdoor-air temperature.
2) Heating-water supply temperature.
3) Heating-water supply temperature set point.

4) Control-valve position.

2. Scope: Heating-water system.
3. Purpose: Control of heating-water supply temperature at heating-water supply temperature input device <Insert device designation> in response to variable outdoor-air temperature input; [electric, outdoor-air-reset controller] [outdoor-air sensor].
4. Conditions of the Test: Outdoor-air temperature input value may be overridden for this test.

   a. Low Temperature: Outdoor-air temperature between [minus 30 and 0 deg F] <Insert temperature range>.
   b. Midrange Temperature: Outdoor-air temperature between [30 and 45 deg F] <Insert temperature range>.
   c. High Temperature: Outdoor-air temperature above [65 deg F] <Insert temperature>.

5. Acceptance Criteria: Heating-water supply temperature resets in straight-line relationship with outdoor-air temperature for the following reset schedule. Under all conditions, heating-water supply temperature is within [2.0 deg F] <Insert temperature> of set point.

   a. [195 deg F] <Insert temperature> heating water when outdoor-air temperature is [minus 30 deg F] <Insert temperature>.
   b. [130 deg F] <Insert temperature> heating water when outdoor-air temperature is [65 deg F] <Insert temperature>.
   c. Under all conditions, heating-water supply temperature is within plus or minus [2.0 deg F] <Insert temperature> of set point.

C. Control Primary Circulating Pump(s):

1. Prerequisites: Installation verification of the following:

   a. Startup of heating-water pump(s) <Insert pump designations>.
   b. Input Device: Outdoor-air temperature; [electric, outdoor-air-reset controller] [outdoor-air sensor].
   c. Output Device: Heating-water pump; [starter] [DDC system command to starter] relay.
   d. Display the following at the operator's workstation:

      1) Outdoor-air temperature.
      2) Operating status of primary circulating pump(s).

2. Scope: Heating-water pump(s) <Insert pump designations> and associated controls.
3. Purpose: On-off control of heating-water pump(s) in response to variable outdoor-air temperature input; [electric, outdoor-air-reset controller] [outdoor-air sensor].
4. Conditions of the Test:

   a. High Temperature: Outdoor-air temperature above [65 deg F] <Insert temperature>.
   b. Low Temperature: Outdoor-air temperature below [65 deg F] <Insert temperature>.

5. Acceptance Criteria:

a. High Temperature: Pump(s) are off when outside-air temperature is above [65 deg F] <Insert temperature>.
b. Low Temperature: Pump(s) are on when outside-air temperature is below [65 deg F] <Insert temperature>.

3.4 CENTRAL REFRIGERATION SYSTEM COMMISSIONING TESTS

A. Start and Stop Condenser-Water Pump(s):

1. Prerequisites: Installation verification of the following:

a. Startup of condenser-water pump(s) <Insert pump designations>.
b. Startup of cooling tower <Insert cooling tower designations>.
c. Input Device: Water pressure transducer <Insert device designation>.
d. Input Device: [Space thermostat] [DDC system outdoor-air temperature] <Insert device designation>.
e. Input Device: [Time clock] [DDC system time schedule] <Insert device designation>.
f. Output Device: Hard wired through motor starter; [DDC system binary output] <Insert device designation>.
g. Output Device: [Time clock] [Binary output] <Insert device designation>.
h. Display the following at the operator's workstation:

1) Low-level cooling-tower sump alarm.
2) Outdoor-air temperature.
3) Cooling (software) demand indication.
4) Time and time schedule.
5) Condenser-water pump(s) on-off status.
6) Condenser-water pump(s) on-off indication.
7) Condenser-water flow indication.

2. Scope:

a. Condenser-water system, including condenser-water pump(s), cooling towers, and associated controls.

3. Purpose:

a. Condenser-water pump(s) lockout.
b. Condenser-water pump(s) start.
c. Condenser-water pump(s) shutdown.
d. Low-level cooling-tower sump alarm.
e. Condenser-water pump(s) time-of-day schedule.

4. Conditions of the Test:

a. Verify Lockout: Start with condenser-water pump enable-input devices in the "disable" state to prevent pump start. One-by-one, place the enable-input devices in the "enable" state, and then return each to the "disable" state before placing the next enable-input device to the "enable" state.

b. Verify Start: Start with condenser-water pump enable-input devices in the "disable" state to prevent pump start. One-by-one, place the enable-input devices in the "enable" state.
c. Verify Shutdown: Place all enable-input devices in the "enable" state to allow the pump(s) to start. One-by-one, place the enable-input devices to their "disable" state, and then return each to the "enable" state before placing the next enable-input device to the "disable" state.
d. Verify Schedule: Compare condenser-water pump start and stop schedule times with Owner-approved time-of-day schedule.

5. Acceptance Criteria:

a. Lockout: No single enable-input device starts the pump(s) when released to the enable state.
b. Start: Condenser-water pump(s) start when and only when all enable-input devices are in the "enable" state.
c. Shutdown: Each enable-input device stops the condenser-water pump(s) when placed in the "disable" state, regardless of the state of other enable-input devices.
d. Schedule: Condenser-water pump start and stop schedule times agree with Owner-approved time-of-day schedule.

B. Start and Stop Chilled-Water Pump(s):

1. Prerequisites: Installation verification of the following:

a. Startup of chilled-water pump(s) <Insert pump designations>.
b. Startup of condenser-water pump(s) <Insert pump designations>.
c. Startup of cooling tower <Insert cooling tower designations>.
d. Input Device: Flow switch in condenser-water circuit<Insert device designation>.
e. Output Device: [Starter] [DDC system command to starter] relay.
f. Display of the following at the operator's workstation:

1) Chilled-water flow indication.
2) Condenser-water flow indication.
3) Chilled-water pump(s) on-off status.
4) Chilled-water pump(s) on-off indication.

2. Scope: Chilled-water system, including chilled-water pump(s), associated controls, and condenser-water system controls.
3. Purpose:

a. Chilled-water pump(s) start.
b. Chilled-water pump(s) shutdown.

4. Conditions of the Test:

a. Verify Start: Start with chilled-water pump enable-input device in the "disable" state to prevent pump start. Place the enable-input device in the "enable" state.
b. Verify Shutdown: Start with the enable-input device in the "enable" state to allow the pump(s) to run. Then place the enable-input device to the "disable" state.

5. Acceptance Criteria:

a. Start: Chilled-water pump(s) start when and only when the enable-input device is in the "enable" state.
b. Shutdown: The enable-input device stops the chilled-water pump(s) when placed in the "disable" state.

C. Start and Stop Cooling-Tower Fans(s):

1. Prerequisites: Installation verification of the following:

a. Input Device: Flow switch in condenser-water circuit <Insert device designation>.
b. Output Device: [Starter] [DDC system command to starter] relay.
c. Display:

1) Condenser-water flow indication.
2) Cooling-tower fan(s) on-off indication.

2. Scope: Condenser-water system, including cooling tower, condenser-water pump(s), and associated controls.
3. Purpose:

a. Cooling-tower fan(s) start.
b. Cooling-tower fan(s) shutdown.

4. Conditions of the Test:

a. Verify Start: Start with cooling-tower fan enable-input device in the "disable" state to prevent fan(s) start. Place the enable-input device in the "enable" state.
b. Verify Shutdown: Start with the enable-input device in the "enable" state to allow the fan(s) to run. Then place the enable-input device to the "disable" state.

5. Acceptance Criteria:

a. Start: Chilled-water pump(s) start when and only when the enable-input device is in the "enable" state.
b. Shutdown: The enable-input device stops the chilled-water pump(s) when placed in the "disable" state.

D. Alternative Chiller(s):

1. Prerequisites: Installation verification of the following:

a. Input Device: [Electric alternator] [DDC system software] <Insert device designation>.
b. Output Device: [Chiller] [DDC system command to chiller] <Insert device designation> terminal strip.
c. Display:

1) Chiller(s) on-off indication.
2) Chiller failure alarm.

2. Scope:

a. Chilled-water system and associated controls.

b. Condenser-water system and associated controls.

3. Purpose:

a. Lead-lag rotation of chillers.
b. Replacement of failed chiller in rotation.
c. Adding and dropping chillers as follows: <Insert sequence and parameters>.
d. Replacement of failed chiller in add/drop sequence.
e. Chiller failure alarm initiation.

4. Conditions of the Test:

a. Lead-Lag Rotation - Chiller Start: Create a number of chilled-water system start-stop cycles equal to the number of chillers plus one.
b. Lead-Lag Rotation - Lead Chiller Fail: Disable the lead chiller while it is running.
c. Lead-Lag Rotation - Lag Chiller Fail: Disable a lag chiller while it is running.
d. Lead-Lag Rotation - Chiller Start Fail: Disable a chiller while it is in standby mode. Initiate a lead-lag rotation call for the disabled chiller to start.
e. Add/Drop Sequence - Increasing Demand: Increase chilled-water demand incrementally to observe the corresponding addition of chillers. Increase demand gradually as the load approached the set point for adding the next chiller to permit observation of the actual load at the time the next chiller is enabled.
f. Add/Drop Sequence - Decreasing Demand: Decrease chilled-water demand incrementally to observe the corresponding dropping of chillers. Decrease demand gradually as the load approached the set point for dropping the next chiller to permit observation of the actual load at the time the next chiller is disabled.
g. Add/Drop Sequence - Operating Chiller Fail:
h. Add/Drop Sequence - Chiller Start Fail:

5. Acceptance Criteria:

a. Lead-Lag Rotation - Chiller Start: On each chilled-water system start event, the [other] [next] chiller in rotation starts as the lead chiller, and the previous lead chiller is designated as the [last]lag chiller.
b. Lead-Lag Rotation - Lead Chiller Fail: When the lead chiller fails, the [other] [next] chiller in rotation starts as the lead chiller, and a chiller failure alarm is initiated for the failed chiller.
c. Lead-Lag Rotation - Lag Chiller Fail: When the lag chiller fails, [the next chiller in rotation starts as the lead chiller, and]a chiller failure alarm is initiated for the failed chiller.
d. Lead-Lag Rotation - Chiller Start Fail: When a chiller fails to start, [the next chiller in rotation starts in its place, and]a chiller failure alarm is initiated for the failed chiller.
e. Add/Drop Sequence - Increasing Demand: Chillers are added at the specified load set point, plus or minus [5] <Insert number> percent. Chilled-water supply temperature remains stable within plus or minus [2.0 deg F] <Insert temperature> of set point.
f. Add/Drop Sequence - Decreasing Demand: Chillers are dropped at the specified load set point, plus or minus [5] <Insert number> percent. Chilled-water supply temperature remains stable within plus or minus [2.0 deg F] <Insert temperature> of set point.
g. Add/Drop Sequence - Operating Chiller Fail: When an operating chiller fails, the next chiller in sequence starts and a chiller failure alarm is initiated for the failed chiller.

h. Add/Drop Sequence - Chiller Start Fail: When a chiller fails to start, the next chiller in sequence starts in its place, and a chiller failure alarm is initiated for the failed chiller.

3.5 TERMINAL UNIT EQUIPMENT COMMISSIONING TESTS

A. Variable-Air-Volume Terminal Air Units with Coils:

1. Prerequisites: Installation verification of the following:

a. Occupancy Input Device: Occupancy sensor.
b. Occupancy Output Device: DDC system binary output.
c. Room Temperature Input Device: [Room thermostat] [Electronic temperature sensor].
d. Room Temperature Output Device: [Pneumatic] [Electronic] damper actuators and control-valve operators.
e. Display the following at the operator's workstation:

1) Room/area served.
2) Room occupied/unoccupied.
3) Room temperature indication.
4) Room temperature set point.
5) Room temperature set point, occupied.
6) Room temperature set point, unoccupied.
7) Air-damper position as percentage open.
8) Control-valve position as percentage open.

2. Scope: Variable-air-volume terminal air units with [hydronic] [steam] coils in supply-air systems, and associated controls.
3. Purpose:

a. Occupancy-dependent room temperature set-point reset.
b. Room temperature control.

4. Conditions of the Test:

a. Commissioning Test Demonstration Sampling Rate: [10] <Insert number> percent of each model/size unit.
b. Temperature Control - Occupied: Start with the room unoccupied. Occupy the room and observe the change to occupied status. Observe temperature control until room temperature is stable at occupied set point plus or minus [1.0 deg F] <Insert temperature>.
c. Temperature Control - Unoccupied: Start with the room occupied. Vacate the room and observe the change to unoccupied status. Observe temperature control until room temperature is stable at unoccupied set point plus or minus [1.0 deg F] <Insert temperature>.

5. Acceptance Criteria:

a. Temperature Control - Occupied:

1) Control system status changes from "occupied" to "unoccupied" after the specified time.

2) Room temperature is stable at occupied set point plus or minus [1.0 deg F] <Insert temperature> within [10] <Insert number> minutes of occupancy. Room temperature does not overshoot or undershoot set point by more than [2.0 deg F] <Insert temperature> during transition.

b. Temperature Control - Unoccupied:

1) Control system status changes from "unoccupied" to "occupied" [immediately] [after five minutes of continuous occupancy].
2) Room temperature is stable at unoccupied set point plus or minus [1.0 deg F] <Insert temperature> within [30] <Insert number> minutes of occupancy.

3.6 AIR-HANDLING SYSTEM COMMISSIONING TESTS

A. Supply Fan(s) Variable-Volume Control:

1. Prerequisites: Installation verification of the following:

a. Volume Control Input Device: [Static-pressure transmitter] [Differential-pressure switch] sensing supply-duct static pressure referenced to conditioned-space static pressure.
b. Volume Control Output Device: [Receiver controller] [DDC system analog output] [DDC system analog output to digital-to-pneumatic transducer] to modulating damper actuator. Set inlet guide vanes to [minimum] [closed] position when fan is stopped.
c. Volume Control Input Device: [Static-pressure transmitter] [Differential-pressure switch] sensing supply-duct static pressure referenced to conditioned-space static pressure.
d. Volume Control Output Device: [Receiver controller] [DDC system analog output] to motor speed controller. Set variable-speed drive to minimum speed when fan is stopped.
e. High-Pressure Input Device: Static-pressure transmitter sensing supply-duct static pressure referenced to static pressure outside the duct.
f. High-Pressure Output Device: [Receiver controller] [DDC system binary output] to [alarm panel] [motor starter].
g. Display the following at the operator's workstation:

1) Supply-fan-discharge static-pressure indication.
2) Supply-fan-discharge static-pressure set point.
3) Supply-fan airflow rate.
4) Supply-fan [inlet vane position] [speed].

2. Scope: Variable-air-volume supply fan units and associated controls.
3. Purpose:

a. Supply-air discharge static pressure control.
b. Response to excess supply-air discharge static pressure condition.

4. Conditions of the Test:

a. Minimum supply-air flow.
b. Midrange Supply-Air Flow: [50 to 60] <Insert number(s)> percent of maximum.
c. Maximum supply-air flow.

d. Excess supply-air discharge static pressure.

5. Acceptance Criteria:

a. At all supply-air flow rates, and during changes in supply-air flow, discharge air static pressure is at set point plus or minus [2] <Insert number> percent.
b. Fan stops and an alarm is initiated at the operator's workstation when supply-air discharge static pressure is at the excess static pressure plus or minus [2] <Insert number> percent.

B. Air-Handler Mixed-Air Control:

1. Prerequisites: Installation verification of the following:

a. Minimum Position Input Device: [Time clock] [DDC system time schedule].
b. Output Device: [Receiver controller] [DDC system analog output] [DDC system analog output to digital-to-pneumatic transducer] to modulating damper actuator(s).
c. Heating Reset Input Device: [Room thermostat] [DDC system software].
d. [Supply] [Mixed]-Air Temperature Input Device: [Duct-mounted thermostat] [Electronic temperature sensor].
e. Cooling Reset Input Device: Outdoor- and return-air, duct-mounted [thermostats] [electronic temperature sensors].
f. Display the following at the operator's workstation:

1) Mixed-air-temperature indication.
2) Mixed-air-temperature set point.
3) Mixed-air damper position.

2. Scope: Air handler with mixed-air control and associated controls.
3. Purpose:

a. Occupied time control.
b. Minimum damper position control.
c. Heating reset control.
d. [Supply] [Mixed]-air temperature control.
e. Cooling reset control.
f. Unoccupied time control.

4. Conditions of the Test:

a. Occupied Time Control: Start in unoccupied schedule. Advance to occupied schedule time.
b. Minimum Damper Position Control: Command system to mode in which minimum damper position is required.
c. Heating Reset Control: Create a call for heating.
d. [Supply] [Mixed]-Air Temperature Control: Override [supply] [mixed]-air temperature set point to a value [2.0 deg F] <Insert temperature> above current [supply] [mixed]-air temperature.
e. Cooling Reset Control: Override outdoor-air [temperature to a value that exceeds return-air temperature] [enthalpy to a value that exceeds return-air enthalpy].
f. Unoccupied Time Control: Advance to unoccupied schedule time.

g. Control Data Trend Log: Set up a data trend log of the following input device values and output device commands. Record data at [hourly] <Insert alternative recording frequency> intervals. Submit trend data for [24-hour] <Insert time> periods in which natural conditions require heating reset control, [supply] [mixed]-air temperature control, and cooling reset control.

1) Minimum position input device.
2) Heating reset input device.
3) [Supply] [Mixed]-air temperature input device.
4) Cooling reset input device.

5. Acceptance Criteria:

a. Occupied Time Control: Mixed-air control is active in occupied mode.
b. Minimum Damper Position Control: Controller [opens minimum outdoor-air dampers] [positions outdoor-air dampers to minimum position].
c. Heating Reset Control: Controller [closes minimum outdoor-air dampers] [sets outdoor-air dampers to minimum position].
d. [Supply] [Mixed]-Air Temperature Control: Controller modulates outdoor-, return-, and relief-air dampers to maintain temporary [supply] [mixed]-air temperature set point plus or minus [1.0 deg F] <Insert temperature>.
e. Cooling Reset Control: Controller sets outdoor-air dampers to minimum position when outdoor-air [temperature exceeds return-air temperature] [enthalpy exceeds return-air enthalpy].
f. Unoccupied Time Control: Controller positions outdoor- and relief-air dampers closed and return-air dampers open.
g. Control Data Trend Log: Data verifies control according to sequence of control.

END OF SECTION 230800

SECTION 230900 - INSTRUMENTATION AND CONTROLS FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

A. Furnish and install a new state of art Direct Digital Control System with all the latest hardware and software application necessary to perform the control sequence of operations.

B. Provide a totally BACnet based system with MS/TP and IP networks, including a server with the DDC operating software for unlimited amount of data managers and unitary controllers. All controllers as well as all input/outputs devices shall communicate using the protocols and network standards as defined by Ashrae standards. It is not acceptable to use gateways for communication to controllers. The use of proprietary protocols on any part of the DDC system is prohibited.

C. The control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to applications & system controllers operating in multiuser, multitasking environment on an IP Ethernet network independent from the building IT infrastructure. A browser based solution compliant with the Integration and Architecture Guidelines will interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

D. Furnish a rack server with the DDC operating building management system software including all the necessary accessories for mounting and connecting to the IT owner¢s rack for remote access or to act as a virtual server accessible at any given point of the owner¢s IT infrastructure. Additionally, an user interface station with a 27• monitor, keyboard and printer shall be provided in the level (s) or floor (s) where main HVAC equipment is located.

E. DDC Software

1. Shall adhere to all requirements as established by the building owner.
2. Shall be integrated into the Centralized Automation Platform
3. Shall be delivered via a 19 inch rack mountable server, server will be provided by the contractor and meet the minimum hardware requirements of the provided solution.
4. Must be on the latest Windows 7 or Windows Server operating system.
5. Shall provide role based portals that will display customized view based on secure access. Authorized users will be able to both monitor and command systems based on their function
6. Shall provide both 2D and 3D graphics.
7. Will support touch screens.
8. Provide 24x7 proactive self-monitoring of all systems and forward all alarms via the requirements as established by the building owner.
9. Shall provide a self-contained reporting tool and be able to view, print and export reports.

F. All mechanical equipment controllers will support TCP/IP, BACnet IP, and BACnet Ethernet communications. Controllers will connect directly to the Ócore & shell• Ethernet network for communications

G. Provide and install all interconnecting cables between all operator terminals and peripheral devices, such as printers as well as connectivity to end user IT network for remote access supplied under this section.

H. The DDC contractor shall get familiarize with all related specification sections associated with HVAC equipment or any system monitor or control by the DDC system including commissioning planning, power requirements, low voltage wiring guidelines.

I. Provide integration capabilities with the owner¢s Centralized Automation Platform (CAP). The intent of the integration is to form a cohesive Enterprise Information System for data acquisition and management with the ability to have a single seat access to all integrated systems. The Building Management System (BMS) shall have management level monitoring and control capabilities of multiple integrated building systems.

J. Items of work included are as follows:

1. Provide submittals that meet the requirements below for approval.
2. Coordinate installation schedule with the mechanical contractor and general contractor.
3. Provide installation of all panels and devices unless otherwise stated.
4. Provide miscellaneous control wiring for HVAC and related systems regardless of voltage.
5. Provide engineering and field technician labor to program and commission software for each system and operator interface. Submit commissioning reports for approval.
6. Provide project management labor to manage all aspects of the installation process, including but not limited to, coordination with contracting parties, project administration and scheduling, labor management and field supervision of BMS contractor and subcontractor staff.
7. Provide testing, demonstration and training as specified below.
8. Provide electrical products which have been tested, listed and labeled by Underwriters Laboratories, and comply with NEMA standards and the National Electric Code.
9. Provide a comprehensive detailed operator and technical training program.
10. DDC vendor shall appoint experience project manager and technicians to manage the project and assist in all phases of the system installation, start-up and commissioning as well as balancing.
11. Maintain a journal of all DDC field installation activities, this journal shall describe the daily progress made on project from starting date to the last day of the DDC installation scope of work. A copy of this journal shall be submitted with the as-built drawings.
12. An icon shall be included in the server as a Óshortcut• which will allow quick access to all as-built control drawings, associated mark-up mechanical drawings, end devices datasheets and control sequence of operations. This file will be accessed as a batch of pdf files easily accessible and readable at the server. This will allow the local user, a third party service company or the DDC contractor to access and look up the technical information regarding any controlled system.
13. Provide installation of control panels

1.2 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:

1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.

2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:

    a. Water Temperature: Plus or minus 1 deg F.
    b. Water Flow: Plus or minus 5 percent of full scale.
    c. Water Pressure: Plus or minus 2 percent of full scale.
    d. Space Temperature: Plus or minus 1 deg F.
    e. Ducted Air Temperature: Plus or minus 1 deg F.
    f. Outside Air Temperature: Plus or minus 2 deg F.
    g. Dew Point Temperature: Plus or minus 3 deg F.
    h. Temperature Differential: Plus or minus 0.25 deg F.
    i. Relative Humidity: Plus or minus 5 percent.
    j. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
    k. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
    l. Airflow (Terminal):Plus or minus 10 percent of full scale.
    m. Air Pressure (Space): Plus or minus 0.01-inch wg.
    n. Air Pressure (Ducts): Plus or minus 0.1-inch wg.
    o. Carbon Monoxide: Plus or minus 5 percent of reading.
    p. Carbon Dioxide: Plus or minus 50 ppm.
    q. Electrical:Plus or minus 5 percent of reading.

1.3 SEQUENCE OF OPERATION

A. Refer to sequence of operation section of mechanical specifications (section 230993).

B. Contractor shall read and interpret these sequences and prepare for Engineer's review a more detailed sequence corresponding to the exact parameters of the program to be entered into controllers. Where self-tuning or canned or preprogramed blocks are used, reference may be made to these blocks of code or programs together with a submission clearly documenting the features and operation of the code block/program and the standard sequence of operation for that program.

C. The level of detail of all sequences submitted shall exceed the engineer's sequence and shall be sufficient for the commissioning agent to fully field verify the correct operation of all factory and custom programming in the controller.

D. Submissions of sequences for review that are or are verbatim or nearly verbatim reproductions of engineer's sequences may be rejected at Engineer's discretion as being unacceptable for review.

E. Incomplete documentation of the sequence of operation to be programmed, including withholding adequate documentation of the behavior of canned or vendor standard programs on the basis of that information being Óproprietary• shall be sufficient grounds for Engineer to withhold approval.

F. A text sequence shall be presented for review. The entire text sequence shall exist within the commented code. A copy of the commented code or graphical programming language with the relevant portions of the sequence of operation identified to each block of code shall be submitted for record following approval of text sequences and shall form part of the as built submission.

G. The algorithms must be approved by the Engineer and the building Facilities Systems Engineer.

1.4 ACTION SUBMITTALS

A. The DDC contractor is responsible to request and receive all third party equipment submittal as well as wiring diagram indicating point to point terminations related to DDC control to develop control submittal drawings. In the event there is a delay in obtaining specific information the DDC contractor shall add notes in the control submittal indicating the control intent design and add related notes explaining the coordination efforts made to obtain necessary details. Holding submittal for not obtaining this information is not acceptable.

B. If project requires DDC interface between the DDC system and third party packaged equipment, the DDC contractor shall be responsible to request and received any require mapping tables from the third party equipment manufacturer. This information shall be provided accordingly to accomplish proper integration into the DDC system and to avoid delays.

C. Partial Submittal for controls and end devices are not acceptable. Control Submittal as well as end devices data-sheets shall be provide together as one package submission to engineer for approval.

D. Control Submittal drawings are NOT only for DDC contractor use but it shall become an important piece of information for building operators and owners and it shall be organize in such way to follow a logical and easy pattern therefore the control submittal shall follow the same flow of information as the mechanical drawings from lower level floor HVAC equipment to upper level floor equipment and it shall include separate and dedicate sections including but not limited to the following page types:

E. Network Riser: This diagram shall indicate how the DDC contractor plans to interconnect all data manager controllers via an independent communication riser in a multi-level facility and within an owner¢s IT network for remote access. This diagram shall be separate from the BACnet MS/TP riser. Proving a table schedule is not acceptable and submittal will be rejected as this type of submission has limited and not enough detail. Avoid placing non-network devices on this diagram, if there is a need to indicate distance relationship from a non-network device to a network device indicate such a detail on a separate page.

F. BACnet Riser: This diagram should indicate the BACnet communication bus connection between specific application unitary controllers and the associated data manager within each multi-level facility. Typical diagrams for similar system is not acceptable. This diagram shall include only communication devices. If a distance between a hardwire device and its associated control panel needs to be indicate then use a separate page. Providing a table schedule and combining BACnet Riser and Network into one page is not acceptable and submittal will be rejected as this type of submission has limited and not enough detail. Avoid placing non-ms/tp devices such as valves, DPT on this diagram, if there is a need to indicate distance relationship from an end device to a MS/TP device indicate such a detail on a separate page. Each MS/TP communication loop shall have a return loop at the associated Data-manager controller.

G. BACnet Communication Layout: this diagram shall indicate hot the DDC vendor contractor plans to run the communication network on a specific floor. Using the pertained mechanical drawing floor layout as a reference to mark and illustrate such a communication run is acceptable.

H. Flow Diagrams per system: This diagram shall indicate a representation of airflow or water flow on a HVAC system and it shall be compose of all associated end devices with their respective tagging or designed name. Typical diagrams for similar systems is not acceptable.

I. System Control Panel Point List per system: This diagram shall contain a full point list of hardwire inputs and outputs per system to each controller.

J. Wire Pull diagrams: This diagram shall indicate each control point wire gauge and amount of conductor per point pull to a dedicated control panel. Typical diagrams for similar system is not acceptable. Providing table schedule is not acceptable and submittal will be rejected as this type of submission has limited and not enough detail.

K. Point to Point wiring diagrams for each control panel: This diagram shall include each control point wire connection from field and inside a control panel, This diagram shall include any relay interlock diagram accompanied by a written explanation of the interlock intent. Each wire shall be label including color code. Providing a table schedule format for control panels is not acceptable and submittal will be rejected as this type of submission is not specific and detail enough. Typical diagrams for similar system is not acceptable.

L. Control Panel layout: This diagram indicate the position of each controllers, wires, wire duct, terminal blocks, relays, power supplies, transformers. Each of this components shall be labeled to ease identify each part. Submittal will be reject if this information is missing from submission package.

M. Valve Schedule: this schedule indicate all the valve selection made by the DDC contractor. It shall include flow characteristics, gpm, design pressure drops, actual pressure drop, design cv, calculated cv, valve body pressure rating and close-off pressure rating as well as safe fail position.

N. In the event 24vac power distribution loops are part of the DDC scope of work then the DDC contractor need to supplied as part of the submittal a detailed breakdown of how the low voltage power wiring is distributed among unitary controllers. Indicating location of panel, type of wire gauge and amount of conductors use as well as power loads on controllers and end devices assigned to an individual power loop transformer.

O. The DDC contractor shall provide as part of the control submittal the label system intended to be used to identify each control panel for each control system.

P. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

1. IP System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator rack server equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

Q. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
3. Wiring Diagrams: Power, signal, and control wiring.
4. Details of control panel faces, including controls, instruments, and labeling.
5. Written description of sequence of operation.
6. Schedule of dampers including size, leakage, and flow characteristics.
7. Schedule of valves including flow characteristics.
8. IP System Hardware:

    a. Wiring diagrams for control units with termination numbers.
    b. Schematic diagrams and floor plans for field sensors and control hardware.
    c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.

9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
10. Controlled Systems:

    a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
    b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
    c. Written description of sequence of operation including schematic diagram.
    d. Points list.

R. Samples for Initial Selection: For each color required, of each type of thermostat [or sensor] cover with factory-applied color finishes.

S. Samples for Verification: For each color required, of each type of thermostat [or sensor] cover.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. The following shall be included:

1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
2. Interconnection wiring diagrams with identified and numbered system components and devices.
3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
5. Calibration records and list of set points.

B. Contractor shall not order material or begin fabrication or field installation until receiving authorization to proceed in the form of an approved submittal.

C. Submit to Facilities Systems Engineering prior to software generation:

1. Approved submittals
2. Tree outline of color graphics
3. Samples of trends and history report
4. List of alarm points limits, classification, message interlocks with devices, and other relevant alarm information.
5. Initial setpoint values
6. List of advisories for operators for manual control.

D. Software and Firmware Operational Documentation: Include the following:

1. Software operating and upgrade manuals.
2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.
5. Software license required by and installed for BAS Software and control systems.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.

B. Engineering, drafting, programming, and graphics generation shall be performed by the local branch engineers and technicians directly employed by the Building Management System Contractor.

C. Supervision, checkout and commissioning of the system shall be by the manufacturer's authorized branch engineers and technicians directly employed by the Building Management System contractor. They shall perform commissioning and complete testing of the BMS system.

D. DDC System contractor shall convene a pre-submittal meeting with the engineer, commissioning agent and owner within one month of the notice to proceed. The purpose of this meeting is to review the sequences of operation, outline where the proposed system deviates from the specified sequence of operation, and identify potential problems with the specified sequence. Once the sequences of operation are agreed to by all parties, the contractor shall proceed with the formal controls submittal process. DDC System contractor shall submit a print out of all graphics proposed for the project within one month following submittal approval for review jointly by the owner, engineer, and commissioning agent. DDC System Contractor will be required to demonstrate the prescribed operations while in the Owners office. The Owner, Engineer, Construction Manager, Commissioning Agent and Mechanical Contractor may be present to observe and evaluate the demonstration.

E. The following items will be reviewed during demonstration:

1. Access to the system through a standard web browser, internet explorer.

2. Ease-of use of the system relating to:

a. Changing Schedule
b. Changing Set Points
c. Modifying Program Logic
d. Modifying Graphics
e. Reviewing Historical Trends
f. Downloading Controllers
g. Review Activity Log
h. Review/Edit/Acknowledge Alarms
i. Programming remote alarms to cellphones and email.

F. Project Sequence - The control system work for this project shall proceed in the following order:

1. Submit and receive approval on the Shop Drawings, Product Data as describe in the section "ACTION SUBMITTALS."

2. Perform the control system installation work, including all field check-outs and tuning.

3. Provide support to TAB personnel as specified under the paragraph "TEST AND BALANCE SUPPORT."

4. Provide support to Commissioning Agent

5. Submit and receive approval of the Controls System Operators Manual specified under the paragraph "CONTROLS SYSTEM OPERATORS MANUALS."

6. Submit and receive approval of the Performance Verification Testing Plan and the Pre-PVT Checklist specified under the paragraph "PERFORMANCE VERIFICATION TESTING."

7. Perform the Performance Verification Testing.

8. Submit and receive approval on the PVT Report.

9. Provide one year trend data

10. Submit and receive approval on the Training Documentation at least 30 days before training.

11. Deliver the final Controls System Operators Manuals.

12. Conduct the Phase I Training.

13. Conduct the Phase II Training.

14. Conduct the Phase III Training.

15. Submit and receive approval of Closeout Submittals.

1.7 TECHNICAL PROPOSAL

A. Provide a detailed technical proposal describing all elements of the system. A schematic system layout shall be provided, showing relation of these elements and a description of how they operationally interrelate. Technical specification data sheets shall be provided for all proposed system components and devices.

B. Provide a paragraph-by-paragraph statement of conformance with the specifications. This statement shall consist of a list of all numbered paragraphs. Where the proposed system complies fully, such shall be indicated by placing the word "comply" opposite the paragraph number. Where the proposed system does not comply, or accomplishes the stated function in a manner different from that described, a full description of the deviation shall be provided.

C. Where a full description of a deviation is not provided, it shall be assumed that the proposed system does not comply with the paragraph in question.

D. Provide a total System Architecture drawing showing typical IP controller part numbers for the types of systems used on this project. Detail the types of networks, speeds and protocols used by each network segment.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Handle, store and protect equipment and materials to prevent damage before and during installation according to manufacturer's recommendations.

B. Replace damaged or defective items.

C. System Software: Update to latest version of software at Project completion.

D. Protect components from humidity and temperature variation, dust and contaminants.

E. If components are stored before installation, keep them within the manufacturer's limit.

1.9 COORDINATION

A. Coordinate location of thermostat and heights as well as control panel and other exposed control sensors in the field prior installation.

B. If thermostat locations are not shown on contract drawings then DDC contractor shall propose and coordinate proper and final locations prior installation following the approval protocol channels. Otherwise, the possible relocation of thermostat shall be at the DDC contractor expense.

C. If thermostat heights are not shown on contract drawings then DDC contractor shall proposed or coordinate final proper locations prior installation following the approval protocol channels. Otherwise, the possible relocation of thermostat heights shall be at the DDC contractor expense.

D. If panel locations are not shown on contract drawings, DDC contractor shall proposed or coordinate final locations prior installation following the approval protocol channels. Otherwise, the possible relocation of control panels shall be at the DDC contractor expense.

E. If location of temperature wells, flow meters, differential pressure transmitters, airflow stations are not indicated on contract drawings then DDC contractor shall proposed or coordinate final proper locations that work in conjunction to meet the design sequence of operations.

F. If DDC contractor requires power wiring for the control panels and it is not part of the DDC scope of work then the DDC contractor shall provide a detailed list of all the control panels requiring power at once following the proper communication channels. This information should be provided prior submitting an official control submittal to avoid delays and to document selected power circuitry and loads.

G. If DDC contractor requires power for any HVAC equipment under the DDC system control then the DDC contractor should notify the GC and mechanical contractor at once.

H. Whenever a valve schedule or damper schedule is approved or release by mechanical contractor, DDC contractor should coordinate the proper delivery of all these materials in order to be install by the pipefitter in a timely manner and avoid delays.

I. Upon approval of control submittal and upon release notification from GC and mechanical contractor, the DDC contractor should advise of any long lead material items for critical operation to avoid delays. This in not limited to control valves, isolation valves, dampers, airflow stations and the DDC contractor should provide an alternate solution to avoid delays to the project schedule.

J. The DDC contractor shall provide a plan for the activation of all DDC controllers as well as a plan for all point to point checkout procedure to the GC and mechanical to work in a synergy manner to start up HVAC equipment within project schedule deadlines.

K. The DDC contractor programming shall be completed offsite and tested offline prior the implementing into the DDC controllers and fine tune programming during the point to point checkout process.

L. The DDC contractor shall provide any necessary tool for the balancer to perform modification on their controller.

M. The DDC contractor technician shall assist during the balancing process as require.

N. The DDC contractor standard graphic layout for typical repeated HVAC equipment such as VAV, FCU, package RTU shall be submitted with the initial control submittal for approval and it shall be ready to download prior commissioning agent testing.

O. The DDC contractor shall submit to facilities systems engineering prior software generation:

1. Approved submittals
2. Tree outline of color graphics
3. Samples of trends and history reports
4. List of alarm point limits, classification, message interlocks with devices, and other relevant alarm notification.
5. Initial setpoint values
6. List of advisories for operators for manual control
7. Software operating and upgrade manuals
8. Program software backup complete with data files.
9. Device address list
10. Print out of software application and graphics screens
11. Software license require by and installed for DDC software and control systems.

1.10 TRAINING

A. Training manuals: the standard operating manual for the system and any special training manuals will be provided for each trainee, with three extra copies left for the operation and maintenance manuals. In addition, copies of the system technical manual will be demonstrated during training and three copies submitted with the operation and maintenance manuals. Manuals shall include detailed description of the subject matter for each session. The manuals will cover all control sequences and have a definitions section that fully describes all relevant words used in the manuals and in all software displays.

B. Conduct trainings that are tailored to the needs and skill-level of the trainees.

C. The trainers will be knowledgeable on the system and its use in buildings. For the on-site sessions, the most qualified trainer(s) will be used. The owner shall approve the instructor prior to scheduling the training.

D. During any demonstration, should the system fail to perform in accordance with the requirements of the Operation and Maintenance manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.

E. The DDC contractor shall discuss the interaction of the controls system as it relates to each HVAC equipment being under control of the building management system (DDC), the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure shall be illustrated.

F. Training shall be break up into three training sessions as follow:

1. Training I (40 hours) Control systems overview: this training may be held on-site or in the supplier¢s facility. If held off-site, the training may occur prior to completion of the final system installation. Upon completion, each student, using appropriate documentation, should be able to perform elementary operations and describe general hardware architecture and functionality of the DDC system.
2. Training II (40 hours): Building systems: the second session shall be held on-site and will consist of actual hands-on training after the completion of system commissioning. the session shall include instruction on:

a. Specific hardware configuration of installed systems in this building and specific instruction for operating the installed system, including HVAC systems, lighting controls and any interface with security and communication systems applicable to the actual scope owe by the DDC contractor.
b. Security levels, alarms, system start-up, shut-down, power outage and restart routines, changing set points and alarms and other typical changed parameters, overrides, freeze protection, manual operation of equipment, optional control strategies that can be considered, energy savings strategies and set points that if changed will adversely affect energy consumption, energy accounting, procedures for obtaining vendor assistance, etc.
c. All trending and monitoring features (values, change of state, totalization, etc.), including setting up, executing, downloading, viewing both tabular and graphically and printing trends. Trainees will actually set-up trends in the presence of the trainer.
d. Every screen shall be completely discussed, allowing time for questions.
e. Use of keypad or plug-in laptop computer at the zone level.
f. Use of remote access to the system via phone lines or networks.
g. Setting up and changing an air terminal unit controller.
h. Graphics generation or modification.
i. Point database entry and modifications
j. Understanding DDC field panel operating programming (when applicable)

3. Training III (20 hours): Follow-up training: the third and final session will be conducted on-site six months after occupancy. The session will be structured to address specific topics that trainees need to discuss and to answer questions concerning operation of the system.

G. Since the owner may require personnel to have more comprehensive understanding of the hardware and software, additional training must be available from the contractor. If the owner requires such training, it will be contracted at a later date. Provide description of available local and factory customer training. Provide costs associated with performing training at an off-site classroom facility and detail what is included in the manufacturer¢s standard pricing such as transportation, meals, etc.

1.11 DDC SYSTEM ARCHITECTURE NETWORK

A. GENERAL

1. The DDC system architecture shall be completely separate from owner¢s IT infrastructure and it shall interact between each other only for remote access purposes and to set up the DDC rack server into the owner¢s IT network.
2. IT infrastructure owner shall provide static IP addresses as require by the ddc contractor¢s equipment.
3. The DDC contractor should comply with all owner it infrastructure security policies for remote access.
4. All data communications protocol shall be Bacnet MS/TP or Bacnet IP.
5. The DDC contractor shall furnish an Ethernet riser communication on a small scale multilevel facility (maximum 15 floor or levels) it shall provide for the primary network an individual cat6 homeruns from DDC server switch/hub to each data manager or primary controller as long as Ethernet maximum distance limitation are maintained.

6. If applicable, the DDC contractor on a medium scale multilevel facility (more than 15 floor or levels up to 30 floors) shall utilize the first initial 15 floor a Ethernet riser then furnish a separate primary network via a multimode fiber optic vertical communication backbone from DDC server to a fiber to Ethernet converter hub to create an extended Ethernet separate riser for the next 15th floors.
7. If applicable, the DDC contractor on a large scale multilevel facility (more than 30 floors) shall furnish an additional fiber multimode run to further extend an Ethernet riser for the next 15th floor. This shall be repeated every additional 15 floors.
8. The DDC vendor is responsible for cat6 horizontal homeruns from the floor level fiber/ethernet converter switch/hub to the individual data manager or primary controllers.
9. All Ethernet switches or fiber to Ethernet converters and associated accessories to be provided by the DDC contractor.
10. The DDC contractor shall follow all the technical requirements in the DDC system architecture design for distance limitations on Ethernet and fiber network.
11. All Ethernet switches or fiber converters should be mounted on a panel enclosure
12. All Ethernet switches or fiber panel enclosure locations should be coordinate with GC.
13. Power wiring require for any DDC contractor¢s Ethernet or fiber switches/hubs shall be provided by division 26 electrical subcontractor.
14. The DDC system shall allow the distribution of system functions such as monitoring and control and graphical user interface etc. across the network to achieve maximum flexibility, accessibility and performance.
15. It is not acceptable to utilize the network to send critical data required by a control algorithm from one controller to another. Critical data shall be a direct hardwire input to the controller containing the control algorithm. If multiple controllers require the same piece of data for a control algorithm, the data shall be a direct hardwire input to each controller.
16. It is not acceptable to restricted access to DDC system data by the hardware configuration of the DDC. Hardware configuration of the DDC network shall be totally open and transparent to the user when accessing data or developing control programs.
17. The DDC contractor design shall be made to allow the co-existence of current and future expansion of data manager controllers and personal computer operator workstations on the same primary network.

B. Primary Peer-to-Peer Network

1. All operator workstations and primary controllers shall directly reside on a network such that communications (i.e., ability to access, edit, modify, add, delete, back up, report, trend, restore all system point database and all programs) may be executed directly between servers, primary control panels, and operator workstations on a peer-to-peer basis.
2. All operator devices either network resident or connected via intranet and internet, shall have the ability to access all point status and application report data or execute control functions for any and all other devices via the primary network or the secondary network.
3. Access to data shall be based upon logical identification of building equipment.
4. It is not acceptable to imposed a hardware or software limits on the number of devices with global access to the network data.
5. The primary network shall provide a high-speed data transfer rates for alarm reporting, quick report generation from multiple controllers and upload/download efficiency between network devices. System performance shall insure that an alarm occurring at any control panel is displayed at any pc workstation, standalone alarm printer and/or control panel within 5 seconds.
6. The primary network shall support of any combination of primary control panels and operator workstations directly connected to the primary network. A minimum of 64 devices and a maximum of 100 devices shall be supported per data manager or primary network controller.

7. The primary network shall provide message and alarm buffering to prevent information from being lost, error detection, correction and re-transmission to guarantee data integrity.
8. The primary network should be capable to do synchronization of real-time clocks between server, primary control panels, and operator workstations, including automatic daylight savings time corrections.
9. The DDC contractor shall provide network wiring as required to ensure total system operation and communication without interruption, even if the network wiring is open in one (1) location.
10. The primary network shall allow the primary control panels to access any data from, or send control commands and alarm reports directly to, any other primary control panel or combination of controllers on the network without dependence upon a central or intermediate processing device.
11. The primary control panel shall send alarm reports to multiple operator workstations without dependence upon a central or intermediate processing device.
12. The peer-to-peer network shall also allow any primary control panel to access, edit, modify, add, delete, back up, restore all system point database and all programs, assign password access and control priorities to each system individually. The logon password (at any pc workstation or portable operator terminal) shall enable the operator to monitor, adjust and control only the system that the operator is authorized for.

C. Secondary Network

1. This network shall connect and support stand-alone secondary control panels and shall communicate bi-directionally with the primary network through primary control panels for transmission of global data. A sufficient number of primary control panels shall be provided for connection of secondary networks based on quantity of secondary controls panels and distance limitations.
2. Secondary control panels shall be arranged on the secondary network in a functional relationship manner with the primary control panels. For example, a VAV secondary control panel on a secondary network of a primary control panel that is controlling the VAV¢s corresponding AHU.
3. A maximum of 60 secondary control panels may be configured on an individual secondary network to insure adequate global data and alarm response times and future space capacity.
4. The secondary network shall be connected to and communicate with the primary control independently.

D. Primary Control Panel Hardwire (Data Manager)

1. Provide one (1) data manager or primary control panel at each floor or level to monitor and sequencing equipment within associated floor.
2. Unless it is noted in the contract documents or drawings, it is not acceptable to have (1) data manager or primary controller serving several floors unless the mechanical equipment is interacting with each other for example: an ahu unit is located on the first floor and all associated VAV boxes are on a second floor if this is the case then it is acceptable.
3. HVAC equipment that interact with each other shall be within the same data manager or primary controller.
4. Spare capacity

a. All primary control panels shall be installed with 30% spare memory capacity for future connections. provide all hardware modules, software modules, processors, power supplies, repeaters etc. required to ensure adding a controller to the spare memory
b. Provide all processors, power supplies and communication controllers so that the implementation of adding a controller to the spare memory only requires the addition of the appropriate: end devices and field wiring.
c. Provide all necessary hardware for a complete operating system as required. All hardware shall reside in each primary control panel and associated server. Primary control panels shall not be dependent upon any higher level computer or another controller for operation.

5. The data manager or primary network controller shall be provided all communication cards needed for project including cards for spare port left on controller.
6. Memory to accommodate all data manager or primary control panel software requirements, including but not limited to, its own operating system and databases, including control processes, energy management applications, alarm management applications, historical/trend data for points specified, maintenance support applications, custom processes, operator i/o, dial-up communications. Controller shall have a minimum of 32 mb ram, 1 mb of flash and 16k eprom or eeprom. controller shall be provided with battery backup capable of supporting all ram, clock functions, ddc database and operating programs within the controller for a minimum of 72 hours in the event of power failure or power interruption (if information is not stored in non-volatile memory).
7. The data manager or primary network controller shall be provided with data collection/ data trend module sized for 10,000 data samples.
8. The data manager or primary network controller shall be provided with power supplies as required for all associated modules, sensors, actuators, etc.
9. The data manager or primary network controller shall be provided with any software modules for all sequences of operation, logic sequences and energy management routines.
10. The data manager or primary network controller shall be provided with a portable operator terminal connection port to allow the temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers or terminals.
11. Monitoring of all industry standard types of interface protocols without the addition of equipment to the primary control panel or additional drives.
12. The operator shall have the ability to manually override automatic or centrally executed commands at the data manager or primary control panels via a display mounted on the front door (for example: Distech controls' horyzon-c displays)
13. Each data manager primary control panel shall continuously perform self-diagnostics on all hardware modules and network communications. The primary control panel shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication with any system.
14. All data manager or primary controller databases and programs shall be stored in non-volatile memory.
15. Each data manager or primary control panel shall support firmware upgrades without the need to replace hardware.
16. Data manager or primary control panels shall provide at least two (2) eia-232c serial data communication ports for operation of operator i/o devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals. Primary control panels shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers or terminals.
17. Immunity to power and noise.

18. Controller shall be able to operate at 90% Ó 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.
19. Operation shall be protected against electrical noise of 5 Ó 120 hz and from keyed radios up to 5w at 1m (3¢).

E. Primary Control Panel Software (Data Manager)

1. Furnish software to form complete operating system for building and energy management
2. DDC software shall be capable to host an unlimited amount of data manager or primary controller for expandability (e.g., EC-net 4 supervisor UNL)
3. Provide all necessary software for a complete operating system as required. All software shall reside in each data manager or primary control panel. Primary control panels shall not be dependent upon any higher level computer or another controller for operation.
4. All programs points shall be identified by a 30 character name and a 16 character point descriptor. The same names shall be displayed at both the data manager or primary control panel(s) (via portable terminal, printer or modem) and the pc operator workstation(s). If there is similar multi-system consistency on point name should be maintained.
5. All digital points shall have a user-defined, 2-state status indication with 8 characters minimum (e.g., summer/winter, enabled/disabled, abnormal/normal).
6. System security

    a. User access shall be secured using individual security passwords and user names.
    b. Passwords shall restrict the user to the objects, applications and system functions as assigned by the system manager.
    c. Data manager or primary controllers shall be able to assign a minimum of 50 passwords access and control priorities to each point individually. the logon password (at any operator interface or portable operator terminal) shall enable the operator to monitor, adjust and control only the points that the operator is authorized for. all other points shall not be displayed at the operator interface or portable terminal. passwords and priorities for every point shall be fully programmable and adjustable.
    d. User log on / log off attempts shall be recorded.
    e. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. the delay time shall be user-definable.

7. Each data manager or primary control panel shall, at a minimum, be provided with software for:

    a. 2-position control, proportional control, proportional plus integral control, proportional, integral, plus derivative control algorithms, all with automatic control loop tuning.
    b. Limiting the number of times each piece of equipment may be cycled within any 1-hour period.
    c. The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads. upon the resumption of power, each ddc controller shall analyse the status of all controlled equipment, compare it with normal occupancy scheduling and turn equipment on or off as necessary to resume normal operations.
    d. Priority load shedding.

e. Energy management routines including time of day scheduling, calendar-based scheduling, holiday scheduling, temporary schedule overrides, start-stop time optimization, automatic daylight savings time switch over, night setback control, enthalpy switch over, peak demand limiting, temperature-compensated duty cycling, heating/cooling interlock, supply temperature reset, priority load shedding and power failure restart.
f. Custom, job-specific processes defined by the user, to automatically perform calculations and special control routines and sequences of operations.

8. Controllers shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.
9. It shall be possible to use any system measured point data or status, any system calculated data, a result from any process or any user-defined constant in any controller in the system.
10. Any process shall be able to issue commands to points in any and all other controllers in the system.
11. Processes shall be able to generate operator messages and advisories to other operator I/O devices. A process shall be able to directly send a message to a specified device or cause the execution of a dial-up connection to a remote device such as a printer or pager.
12. The custom control programming feature shall be documented via English language descriptors.
13. Each controller shall support text comment lines in the operating program to allow for quick troubleshooting, documentation and historical summaries of program development.
14. Controller shall provide a help function key, providing enhanced context sensitive on-line help with task orientated information from the user manual.
15. Generate and receive automatic and manual operator messages and advisories.
16. Comment lines for all programs.
17. Distributed independent alarm analysis and filtering. Reporting of selected alarms during system shutdown and start-up shall be automatically inhibited. a minimum of 6 priority levels shall be provided for each point.
18. Automatically accumulate and store run-time hours for all digital points.
19. Automatically sample, calculate and store consumption totals on a daily, weekly or monthly basis for all analog and pulse input type points.
20. Trend data shall be stored at the primary control panels and automatically uploaded to the pc workstation.
21. Uploads shall occur based on user-defined intervals, manual commands, or automatically when the trend buffer is 80% full. All trend data shall be available for use in any 3rd party personal computer applications located in the DDC system.
22. Primary control panels shall be able to assign password access and control priorities to each system individually. the logon password (at any pc workstation(s) or pot) shall enable the operator to monitor, adjust and/or control only the systems, programs, primary control panel and/or secondary control panels that the operator is authorized for. All other systems, programs, primary and secondary control panels shall not be displayed at the pc workstation, pot or modem. Passwords and priority levels for each system, program, primary control panel and secondary control panel shall be fully programmable and adjustable.
23. Primary control panels shall be able to access any data from, or send control commands and alarm reports directly to, any other primary control panel or combination of controllers on the network without dependence upon a central or intermediate processing device. Primary control panels shall also be able to send alarm reports to multiple operator workstations without dependence upon a central or intermediate processing device.

24. Alarm management shall be provided to monitor and direct alarm information to operator devices. Each DDC controller shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic and prevent alarms from being lost. At no time shall the DDC controllers ability to report alarms be affected by either operator or activity at a pc workstation, local i/o device or communications with other panels on the network.
25. All alarm or point change reports shall include the point's English language description and the time and date of occurrence.
26. The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of 6 priority levels shall be provided for each point.
27. Point priority levels shall be combined with user definable destination categories (pc, printer, DDC controller, etc.) to provide full flexibility in defining the handling of system alarms. Each DDC controller shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.
28. Alarm reports and messages shall be routed to user-defined list of operator workstations or other devices based on time and other conditions. an alarm shall be able to start programs, print, be logged in the event log, generate custom messages and display graphics.
29. In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 200 character alarm message to more fully describe the alarm condition or direct operator response.
30. Each DDC controller shall be capable of storing a library of at least 50 alarm messages. Each message may be assignable to any number of points in the controller.
31. Operator-selected alarms shall be capable of initiating a call to a remote operator device.
32. Scheduling:

    a. Provide a comprehensive menu driven program to automatically start and stop designated object or group of objects in the system according to a stored time.
    b. It shall be possible to define a group of objects as a custom event (i.e., meeting, athletic activity, etc.). Events can then be scheduled to operate all necessary equipment automatically.
    c. For points assigned to one (1) common load group, it shall be possible to assign variable time delays between each successive start and stop within that group

33. The operator shall be able to define the following information:

    a. Time, day.
    b. Commands such as on, off, auto and so forth.
    c. Time delays between successive commands.
    d. There shall be provisions for manual overriding of each schedule by an appropriate operator.

34. It shall be possible to schedule calendar-based events up to 1 year in advance based on 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.
    b. When a group of objects are scheduled together as an
    c. Event, provide the capability to adjust the start and stop times for each member.

d. 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 a 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.
e. Holiday schedules. Provide the capability for the operator to define up to 99 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.

35. Peak demand limiting (PDL)

    a. The peak demand limiting (PDL) program shall limit the consumption of electricity to prevent electrical peak demand charges.
    b. PDL shall continuously track the amount of electricity being consumed, by monitoring one (1) or more electrical kilowatt-hour/demand meters. These meters may measure the electrical consumption (kwh), electrical demand (kw) or both.
    c. PDL shall sample the meter data to continuously forecast the demand likely to be used during successive time intervals.
    d. if the PDL forecasted demand indicates that electricity usage is likely to exceed a user preset maximum allowable level, then PDL shall automatically shed electrical loads
    e. Once the demand peak has passed, loads that have been shed shall be restored and returned to normal control.

36. Temperature-compensated duty cycling.

    a. The dccp (duty cycle control program) shall periodically stop and start loads according to various patterns.
    b. The loads shall be cycled such that there is a net reduction in both the electrical demands and the energy consumed.

37. Automatic daylight savings time switchover: the system shall provide automatic time adjustment for switching to/from daylight savings time.
38. Night setback control. The system shall provide the ability to automatically adjust setpoints for night control.
39. Enthalpy switchover (economizer). The primary controller software shall control the position of the air handler relief, return and outside air dampers. If the outside air enthalpy is below the return air enthalpy, the software will modulate the dampers to provide 100% outside air. The user will be able to quickly changeover to an economizer system based on enthalpy and will be able to override the economizer cycle and return to minimum outside air operation at any time.
40. PID control. A PID (proportional-integral-derivative) algorithm with direct or reverse action and anti-windup shall be supplied. The algorithm shall calculate a time-varying analog value that is used to position an output or stage a series of outputs. The controlled variable, set point and PID gains shall be user-selectable.
41. Provide application software based upon the sequences of operation specified to properly sequence equipment.
42. Staggered start:

    a. This application shall prevent all controlled equipment from simultaneously restarting after a power outage. The order, in which equipment (or groups of equipment) is started, along with the time delay between starts, shall be user definable.

b. Upon the resumption of power, each primary controller shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling and turn equipment on or off as necessary to resume normal operations.

43. Totalization

a. Run-time totalization. Primary controllers shall automatically accumulate and store runtime hours for all digital input and output points. A high runtime alarm shall be assigned, if required, by the operator.
b. Consumption totalization. Primary controllers shall automatically sample, calculate and store consumption totals on a daily, weekly or monthly basis for all analog and digital pulse input type points.
c. Event totalization. Primary controllers shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly or monthly basis for all points. The event totalization feature shall be able to store the records associated with events before reset.

44. A variety of historical data collection utilities shall be provided to manually or automatically sample, store and display system data for all points.
45. DDC controllers shall store point history data for selected analog and digital inputs and outputs:

a. Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each DDC controllers point group. Two (2) methods of collection shall be allowed: either by a pre-defined time interval or upon a pre-defined change of value. Sample intervals of l minute to 7 days shall be provided. Each DDC controller shall have a dedicated ram-based buffer for trend data and shall be capable of storing a minimum of 10,000 data samples.
b. Trend data shall be stored at the DDC controllers and automatically uploaded to the workstation. Uploads shall occur based upon user-defined interval, manual command or automatically when the trend buffers are 80% full.
c. DDC controllers shall also provide high resolution sampling capability for verification of control loop performance. Operator-initiated automatic and manual loop tuning algorithms shall be provided for a minimum of 36 operator-selected PID control loops.
d. Provide capability to view or print trend and tuning reports.
e. the controller shall perform a step response test with a minimum 1-second resolution, evaluate the trend data, calculate the new PID gains and input. These values into the selected loop statement.
f. Loop tuning shall be capable of being initiated either locally at the DDC controller, from a network workstation, or remotely using dial-in modems.
g. For all loop tuning functions, access shall be limited to authorized personnel through password protection.

46. DDC controllers shall automatically accumulate and store run-time hours for all digital input and output points.
47. DDC controllers shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for all analog and digital pulse input type points.
48. DDC controllers shall count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly and monthly basis for all points. The event totalization feature shall be able to store the records associated with a minimum of 9,999.9 events before reset.

F. Secondary Control Panel Hardware (unitary controller)

1. Each secondary control panel shall operate as a stand-alone controller capable of performing its user selectable control routines independently of any other controller in the system. Each secondary control panel shall be a microprocessor-based, multi-tasking, real-time digital control processor.
2. Each primary controller shall be able to communicate with secondary controllers over the secondary network to control terminal equipment only.
3. Each secondary controller shall include all point inputs and outputs necessary to perform the specified control sequences. The secondary controller shall accept input and provide output signals that comply with industry standards. Controllers utilizing proprietary control signals shall not be acceptable. Outputs may be utilized either for 2-state, modulating, floating or proportional control, allowing for additional system flexibility.

4. Each secondary control panel shall, at a minimum, be provided with:

    a. Appropriate NEMA rated enclosure for its application.
    b. A stand-alone real-time digital control microprocessor module.
    c. built-in display (with the exception of VAV controllers)
    d. Secondary network communications ability.
    e. Power supplies as required for all associated modules, sensors, actuators, etc.

5. Input/output points as required.
6. Software as required for all sequences of operation, logic sequences and energy management routines.
7. A portable operator terminal connection port.
8. Auxiliary enclosure for analog output transducers, isolation relays, etc. auxiliary enclosure shall be part of secondary enclosure or mounted adjacent enclosure.
9. Each controller measuring air volume shall include provisions for manual and automatic calibration of the differential pressure transducer in order to maintain stable control and insuring against drift over time.
10. Each controller measuring air volume shall include a differential pressure transducer.
11. SCR control of electric heaters.
12. Fan speed controller for fan powered VAV boxes.
13. Fan relay for fan powered VAV boxes and fan coil units.
14. Communication: each controller shall perform its primary control function independent of other secondary network communication or if secondary network communication is interrupted.
15. Reversion to a fail-safe mode of operation during secondary network interruption is not acceptable.
16. Control algorithms. The controller shall receive its real-time data from the primary controller time clock to insure secondary network continuity. Each controller shall include algorithms incorporating proportional, integral and derivative (PID) gains for all applications. All PID gains and biases shall be field-adjustable by the user via room sensor LCD or the portable operator¢s terminal as specified herein.
17. Control applications. Operating programs shall be field-selectable for specific applications. In addition, specific applications may be modified to meet the user's exact control strategy requirements, allowing for additional system flexibility. Controllers that require factory changes of all applications are not acceptable.
18. Each controller shall include provisions for manual and automatic calibration of the differential pressure transducer in order to maintain stable control and insuring against drift overtime.

19. Manual calibration may be accomplished by either commanding the actuator to 0% via the pot or by depressing the room sensor override switch. Calibration of the transducer at the controller location shall not be necessary.
20. Each secondary control panel shall continuously perform self-diagnostics on all hardware and secondary network communications. the secondary control panel shall provide both local and remote annunciation of any detected component failures or repeated failure to establish communication to the system
21. Controllers shall include all point inputs and outputs necessary to perform the specified control sequences. As a minimum, 50% of the point outputs shall be of the universal type; that is, the outputs may be utilized either as modulating or two-state, allowing for additional system flexibility. In lieu of universal outputs, provide a minimum of 50% spare outputs of each type via additional point termination boards or controllers. Analog outputs shall be industry standard signals such as 24 vac floating control, allowing for interface to a variety of modulating actuators. Terminal equipment controllers utilizing proprietary control signals and actuators shall not be acceptable.
22. Provide each secondary control panel with sufficient memory to accommodate point databases, operating programs, local alarming and local trending. All databases and programs shall be stored in non-volatile memory. The controllers shall be able to return to full normal operation without user intervention after a power failure of unlimited duration.
23. Provide uninterruptible power supplies (UPS) of sufficient capacities for all terminal controllers that do not meet this protection requirement. Operating programs shall be field-selectable for specific applications. In addition, specific applications may be modified to meet the user's exact control strategy requirements, allowing for additional system flexibility.
24. Controller shall have a minimum of 16k eprom or eeprom.
25. The secondary control panels shall be powered from a 24 vac source provided by this contractor and shall function normally under an operating range of 18 Ó 28 VAC(-25% Ó 17%), allowing for power source fluctuations and voltage drops. install plenum data line and sensor cable in accordance with local code and NEC. the DDC contractor shall provide a dedicated power source and separate isolation transformer for each controller to function normally under the specified operating range. the controllers shall also function normally under ambient conditions of 32º Ó 122ºf (0º Ó 50ºc) and 10% Ó 95% RH (non-condensing).
26. Provide each controller with a suitable cover or enclosure to protect the intelligence board assembly. Power supply must be rated at a minimum of 125% of power consumption and shall be of the fused or current limiting type. the DDC contractor shall provide 24VAC power to the terminal units by utilizing:

    a. The existing line voltage power trunk and installing separate isolation transformers for each controller.
    b. Dedicated line voltage power source and isolation transformers at a central location and installing 24 vac power trunk to supply multiple controllers in the area.

27. Environment. The controllers shall function normally under ambient conditions of 32º Ó 122ºf (0º Ó 50ºc) and 10% Ó 95% rh (non-condensing). Provide each controller with a suitable cover or enclosure to protect the circuit board assembly.
28. Immunity to noise. Operation shall be protected against electrical noise of 5 Ó 120hz and from keyed radios up to 5w at 1m (3¢).

G. Secondary Control Panel Software (Unitary Controller)

1. Provide all necessary software for a complete operating system as required. All software shall reside in each secondary control panel. Secondary control panels shall not be dependent upon any higher level computer or another controller for operation.

2. Secondary control panel software configured for CAV or VAV control algorithms shall include provisions for manual and automatic calibration of attached differential pressure transducer in order to maintain stable control and insuring against drift over time. Calibration shall be accomplished by stroking the terminal unit damper actuator to a 0% position so that a 0 cfm air volume reading is sensed. The controller shall automatically accomplish this whenever the system mode switches from occupied to unoccupied or vice versa. Manual calibration may be accomplished by either commanding the actuator to 0% via the pot or by depressing the room sensor override switch. Calibration of the transducer at the controller location shall not be necessary.
3. Each secondary controller shall perform its primary control function independent of primary controller LAN communication, or if LAN communication is interrupted. Reversion to a fail-safe mode of operation during LAN interruption is not acceptable. The controller shall receive its real-time data from the primary control panel time clock to insure LAN continuity.
4. Controllers that require factory application changes are not acceptable.

1.12 Input and Outputs

A. Hardwire input and output points shall connect to the network programmable application and application-specific controller.

B. Input and output points shall be protect so shorting of point to itself, to another point, or to ground will not damage controller.

C. Input and output points shall be protect from voltage up to 24 V of any duration so that contact will not damage controller.

D. There shall be 15% control point spare capacity per system.

E. Analog Inputs: It shall include monitoring of low voltage (zero to 10Vdc), Current (4 to 20 mA) and resistance signals from thermistor and RTD sensors.

1. It shall be compatible with, and field configurable to sensors and transmitters installed.
2. Signal conditioning including transient rejection shall be provided for each AI.
3. Capable of being individually calibrate for zero and span.
4. Incorporate common-mode noise rejection of at least 40dB from zero to 100 HZ for differential inputs, and normal-mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 1000 ohms.

F. Analog Outputs: Output signals shall have a range of 4-20mA dc or 0-10Vdc as required to include proper control of output device.

1. Capable of being individually calibrate for zero and span.

2. AOs shall not exhibit a drift of greater than 0.4 percent of range per year

G. Binary Outputs: Controller binary inputs shall accept contact closure and shall ignore transients of less than 5-ms duration.

1. Isolation and protection against applied steady-state voltage of up to 180-V ac peak.
2. Binary inputs shall include a wetting current of at least 12mA to be compatible with commonly available control devices and shall be protect against effects of contact bounce and noise.

3. Binary inputs shall sense "dry contact" closure without external power (other than that provided by the controller) being applied.
4. Binary Outputs: Controller binary outputs shall include relay contact closures or triac outputs for momentary and maintained operation of output devices.
5. Relay contact closures shall have a minimum duration of 0.1 seconds. Relays shall include at least 180 V of isolation.
6. Electromagnetic interference suppression shall be provide on all output lines to limit transients to non-damaging levels.
7. Triac outputs shall include at least 180 V of isolation.
8. Minimum contact rating shall be 1 A at 24VAC.
9. Binary Outputs shall include two-state operation control.
10. Floating or Pulse with Modulation are NOT ACCEPTABLE.
11. Binary Output shall be selectable for either open or normally close operation and it shall be capable to have verification of operator tracking.

1.13 GRAPHICS

A. GENERAL

1. Provide system graphics as required.
2. Graphic displays shall have full-screen resolution when viewed on the workstation and notebook computers.
3. Dynamic data on graphics pages shall refresh within 10 seconds using an Internet connection
4. The graphics shall show the present value and object name for each of the project's I/O points on at least one graphic page.
5. Arrange point values and names on the graphic displays in their appropriate physical locations with respect to the floor plan or equipment graphic displayed. Graphics shall allow the operator to monitor current status, view zone and equipment summaries, use point-and-click navigation between graphic pages, and edit setpoints and parameters directly from the screens. Items in alarm shall be displayed using a different color or other obvious visual indicator.
6. Provide graphics with the following:

B. Graphic Types

1. Provide at least one graphic display for each piece of HVAC equipment, building floor, and controlled zone.
2. Indicate dynamic point values, operating statuses, alarm conditions, and control setpoints on each display. Provide summary pages where appropriate.

C. Building Floor Plans

1. Provide a overview plan graphic that allow user to navigate between levels, site, floors.

2. Provide a floor plan graphic for each of the building's floors with dynamic display of space temperature and other important data.
3. If used, indicate and provide links to sub-plan areas.
4. If possible, use the project's electronic drawing files for the graphic backgrounds.
5. Provide clear names for important areas. Include room names and numbers where applicable.
6. Include features such as stairwells, elevators, and main entrances.

7. Where applicable, include the mechanical room, HVAC equipment, and control component locations, with corresponding links to the equipment graphics.

D. Sub-plan Areas

1. Where a building's floor plan is too large to adequately display on the screen, sub-divide the plan into distinct areas, and provide a separate graphic display for each area. Provide same level of detail requested in building floor plan section above.

E. HVAC Equipment

1. Provide a graphic display for each piece of HVAC equipment, such as a fan coil unit, VAV terminal, or air handling unit. Equipment shall be represented by a two or three-dimensional drawing.
2. Where multiple pieces of equipment combine to form a system, such as a central chiller plant or central heating plant, provide one graphic to depict the entire plant.
3. Indicate the equipment, piping, ductwork, dampers, and control valves in the installed location. Include labels for equipment, piping, ductwork, dampers, and control valves.
4. Show the direction of air and water flow. Include dynamic display of applicable object data with clear names in appropriate locations.

F. Sequence of Operation:

1. Provide a graphic screen displaying the written out full sequence of operation for each piece of HVAC equipment. Provide a link to the sequence of operation displays on their respective equipment graphics.
2. Include dynamic real-time data within the text for setpoints and variables.

G. Graphic Title:

1. Provide a prominent, descriptive title on each graphic page.

H. Dynamic Update:

1. When the workstation is on-line, all graphic I/O object values shall update with change-of-value services, or by operator selected discrete intervals.

I. Graphic Linking:

1. Provide forward and backward linking between floor plans, sub-plans, and equipment.

J. Graphic Editing

1. Provide installed software to create, modify, and delete the DDC graphics.

1.14 WARRANTY

A. Warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of one (1) year from completion of system demonstration.

B. Hardware and software personnel supporting this warranty agreement shall provide on-site or off-site service in a timely manner after failure notification to the vendor. The maximum acceptable response time to provide this service at the site shall be 24 hours.

C. This warranty shall apply equally to both hardware and software..

PART 2 INSTALLATION

2.1 GENERAL

A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

B. Connect and configure equipment and software to achieve sequence of operation specified.

C. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices in accordance with ADA requirements above the floor.

D. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

E. Install guards on thermostats in the following locations:

1. Entrances.
2. Public areas.
3. Where indicated.

2.2 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Furnish only new material and equipment manufactured by reputable companies regularly engaged in manufacturing the material or equipment for a minimum of three years.

B. The DDC contractor is required to participate in any required inspections and validations by GC, project inspectors, owners, agents, consultant or any other party requiring inspection and validation.

C. It is the responsibility of the DDC contractor to provide any necessary on-site facilities or equipment to execute their work including trenching, scaffolding, lifts, hoists, storage, site offices, communication equipment, etc.

D. The DDC contractor is required to attend all project progress meetings.

E. Install, connect and wire the items included under this section and all other sections of HVAC work. This work includes providing required conduit, wire, fittings, back boxes, transformers and related wiring accessories. All conduit, wiring and accessories shall be installed in accordance with div.26 specifications.

F. Provide, install and terminate all cable, wiring, raceways, control tubing, junction boxes, pull boxes, wire trough, cable tray, Óunistrut• mounting segments/surfaces and required hangers, and supports, sized and typed as required and specified, anchored and adhered as required and specified, etc., to provide a complete job, in accordance with all contract documents.

G. All raceway tubing or conduit is to be 1 inch minimum.

H. All exposed wiring and wiring in mechanical equipment rooms shall be installed in conduit

I. All wiring located outside shall be installed in rigid conduit, seal tide or EMT with compression fittings.

J. Provide conduit and wiring between thermostats and unit heater motors, all control and alarm wiring for all control and alarm devices for all sections of specifications.

K. All 120 volt, single phase, 60 hertz power to every DDC controller panel, HVAC/mechanical equipment controllers, pc console, power supply, transformer, annunciator, modems, printers and to other devices should be provided by div. 26.

L. Control for HVAC intent that the entire building management system except terminal equipment shall be operative under emergency power conditions in the building (if applicable).

M. Provide conduit and wiring between the DDC panels and the temperature, or pressure sensing elements, including low voltage control wiring in conduit.

N. Provide conduit and control wiring for devices specified in this section.

O. Provide conduit and signal wiring between motor starters/disconnect switches in motor control centers and high and/or low temperature relay contacts and remote relays in DDC panels located in the vicinity of motor control centers.

P. Provide conduit and wiring between the pc workstation, electrical panels, metering instrumentation, indicating devices, miscellaneous alarm points, remotely operated contractors, and DDC panels, as shown on the drawings or as specified.

Q. All wiring to be compliant to local building code and the NEC.

R. Provide all conduit wiring for chillers, ac units, etc. as required for a complete and operational system.

S. Stub-ups for all wall space sensors shall be provided by DDC Contractor.

T. The DDC contractor electrical installer shall avoid connection to devices with Óflying leads• , twisting and taping is not acceptable.

U. Cables to end devices shall be uninterrupted. splices in any of the wiring associated with the system installation not acceptable

V. The DDC contractor electrical installer shall mount and wire all loose-shipped controls and panels provided by other mechanical equipment manufacturers as required and associated with low voltage for the entire project mechanical specifications.

W. All wire and cable labels must be installed within 8• (eight inches) of its termination point.

X. The DDC contractor shall furnish appropriate anchors for the surface (wall, ceiling, floor, etc.) and support requirements shall be used. Anchors, used in drywall applications, must provide support to the back side of the wall surface. Plastic, screw-in or any other anchor type that do not provide such support shall be replaced at the DDC contractor¢s expense.

Y. Critical DDC control devices and panels are typically shown in approximate locations on mechanical drawings and are subject to final field validation. Actual field installation of panels, thermostats, sensors, etc. must be validated through the appropriate job site channels prior to installation. Otherwise, the possible relocation of panels or devices shall be at the DDC contractor's expense.

Z. It is the responsibility of the DDC contractor to turn over a trouble-free communication bus free of all ground faults, open lines, and shorts prior to power up. each bus segment shall be tested by the subcontractor to ensure it is: (a) continuous end to end for each wire (b) only one shield ground exists per segment and (c) bus voltages (+ to -, - to com and + to com) are within documented tolerances of the appropriate communications bus.

AA. The DDC contractor is required to be present and immediately address any issues discovered.

BB. The DDC contractor shall not pull any exposed cable on or near sources of excessive heat (hot water, steam pipes, etc.), moisture (un-insulated piping, valves, pumps, etc.), high voltage equipment (light fixtures, MCC¢s switch gear, panel boards, etc) or any other location which could damage or cause interference with the cable.

CC. All communications wiring routing shall be documented on the mechanical or electrical plans. Device addressing and the location of bus end-of-lines, repeaters, routers, coordinators, power supplies and similar equipment shall be documented on the mechanical or electrical plans. These plans shall be kept current and made available, on as progress basis, upon request by the GC or mechanical contractor and it shall be turned over as part of the as-built documentation.

DD. Furnish all penetrations necessary to install the equipment, raceways and piping associated with project documents.

EE. The DDC contractor shall be responsible for all damper and valve actuator mounting, wiring, linkage setup, alignment, end switches, positioners, and other components required to meet sequence of operations.

FF. Provide and install all fire stopping and sealing of the electrical/mechanical penetrations applicable to DDC work. This includes all areas associated with electrical/mechanical penetrations including the area around and inside sleeves and raceways that may provide a path for air infiltration. All fire stopping and sealing must be installed to meet the applicable project specifications and/or other requirements.

GG. Demolishing all wire, raceways, and hangers associated with inactivated control systems.

HH. Once the DDC contractor employee responsible for supervision for a project has commenced work they shall not be removed or replaced from a project without prior written notice and approval from the GC or mechanical contractor. Such notice and request is required to have a minimum of 5 days advance written notice. Any additional costs incurred by the GC or mechanical contractor due to such changes will be back charged to the DDC contractor. Such charges shall include, but be limited to, on or off the project site training, errors or omissions in installation or any other costs, as determined by contract documents to be caused by said change.

II. Prior to installation the DDC contractor electrical installer shall size all wiring to ensure that (a) 24 volt power voltage drop does not exceed 2 volts from source to farthest device under maximum load conditions and (b) inputs used for analog readings shall not exceed 3 ohms of resistance for the entire circuit.

JJ. The DDC contractor electrical installer is required to complete their work in a timely manner in order for the other trades contractors and the owner to have a reasonable amount of time to complete their work and commission the systems prior to the contract completion date. The DDC contractor will be required to provide the specified materials and manpower in accordance with this scope of work during all phases of the project to avoid impacting any contractual milestone finish dates.

KK. For all installed wiring ensure no stray voltages or ground faults are present.

LL. To the extent that DDC subcontractor has failed to comply with any specification, or that the DDC contractor has failed to request written clarification or any specification that is ambiguous, or that the DDC subcontractor has assumed design responsibility for any portion of the work, DDC contractor shall be fully responsible for all costs necessary to provide a complete and operable system capable of meeting the intent of the contract documents.

MM. If it is the DDC contractor to test all Ühardwire interlocks¢ to ensure operation. Ühardwire interlocks¢ are considered any wiring that is not dependent on system input or outputs for functionality. Examples include: 120v circuits, dedicated or shared 24 vac circuits, low limits, high limits, static pressure safety switches, etc.

NN. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

OO. Plenum rated cable shall be acceptable in hung ceilings, walls and raised floors.

PP. Cables for 120 vac wiring and low level signal wiring (i.e., 24vac, 24vdc, 4 Ó 20 ma analog) shall always be run in separate raceways.

2.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
2. Test and adjust controls and safeties.
3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
4. Pressure test control air piping at 30 psig or 1.5 times the operating pressure for 24 hours, with maximum 5-psig loss.
5. Pressure test high-pressure control air piping at 150 psig and low-pressure control air piping at 30 psig for 2 hours, with maximum 1-psig loss.
6. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.

7. Test each point through its full operating range to verify that safety and operating control set points are as required.
8. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
9. Test each system for compliance with sequence of operation.
10. Test software and hardware interlocks.

C. IP Controller Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check instrument tubing for proper fittings, slope, material, and support.
5. Check installation of air supply for each instrument.
6. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
7. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
8. Check temperature instruments and material and length of sensing elements.
9. Check control valves. Verify that they are in correct direction.
10. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
11. Check IP Controller system as follows:

    a. Verify that IP controller power supply is from emergency power supply, if applicable. (NOTE all POE Switches providing power are already on emergency Power)
    b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
    c. Verify that spare I/O capacity has been provided.
    d. Verify that IP controllers are protected from power supply surges. (Note: all IP controllers PoE powered are grounded via the TCGB outlined in section 27)

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

2.4 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:

    a. Check analog inputs at 0, 50, and 100 percent of span.
    b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
    c. Check digital inputs using jumper wire.
    d. Check digital outputs using ohmmeter to test for contact making or breaking.

e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

5. Flow:

a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
b. Manually operate flow switches to verify that they make or break contact.

6. Pressure:

a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

7. Temperature:

a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
b. Calibrate temperature switches to make or break contacts.

8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
10. Provide diagnostic and test instruments for calibration and adjustment of system.
11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

2.5 RECORD DOCUMENTATION

A. Operation and maintenance manuals

1. Three (3) copies of the operation and maintenance manuals shall be provided to the owner's representative upon completion of the project. the entire operation and maintenance manual shall be furnished on compact disc media and include the following for the DDC contractor shall provide:

a. Table of contents.
b. As-built system record drawings. Record drawings shall represent the as-built condition of the system and incorporate all information supplied with the approved submittal.
c. DDC network riser diagram
d. Wiring diagrams
e. Electrical drawings
f. Flow diagrams and device locations

g. Hardware and software points list
h. Bill of materials
i. Sequence of operations.
j. I/O point lists
k. Cut sheets of all equipment installed
l. Manufacturer¢s product data sheets or catalog pages for all products including software.
m. System operator¢s manuals.
n. Archive copy of all site-specific databases and sequences.
o. Interfaces to all third-party products and work by other trades.
p. Training course list.

2.6 BALANCING ASSISTANCE

A. The DDC vendor shall give field support to the Balancer to balance the system by adjusting as necessary the DDC system during the balancing process.

B. This field support shall include:

1. On-site operation and manipulation of control systems during the testing and balancing.
2. Control Setpoint adjustments for balancing all relevant mechanical systems, including VAV systems.
3. Tuning control loops with setpoints and adjustments determined by TAB personnel.

2.7 COMMISSIONING

A. Prior to full operation, the contractor in the presence of the owner¢s representative and facility engineer shall perform a complete demonstration and testing of the system operating functions and alarms. this testing shall take place after having satisfactorily met the requirements of shop drawing acceptance. upon successful completion of system operation, the contractor shall submit a statement in writing stating that the full operation of all systems, functions and alarms has been demonstrated and are operational as well as a listing of all systems, alarms and functions that have been commissioned. all items shall be submitted for review and acceptance to the owner, owner¢s representative and engineer before final acceptance can take place.

B. The DDC vendor contractor shall coordinate with the commissioning agent and provide on-site support to the commissioning agent.

C. The DDC vendor contractor shall review the commissioning specifications and commissioning plan and include all stated and implied DDC system contractor requiremnets in bid.

2.8 PERFORMANCE VERIFICATION TESTING (PVT)

A. General:

1. The PVT shall demostrate compliance of the control system work with the contract requirements. The PVT shall be performed by the contractor and witnessed and approved by Engineer.

2. If the project is phased, provide separate testing for each phase. A Pre-PVT meeting to review the Pre-PVT Checklist is required to coordinate all aspects of the PVT and shall include the Contractor's QA representative, the Contractor's PVT administrator, and the Owner.

B. Performance Verification Testing Plan

1. Submit a detailed PVT Plan of the proposed testing for Engineer approval. Develop the PVT Plan specifically for the control system in this contract. The PVT Plan shall be a clear list of test items arranged in a logical sequence.
2. Include the intended test procedure, the expected response, and the pass/fail criteria for every component tested.
3. The plan shall clearly describe how each item is tested, indicate where assisting personnel are required (like the mechanical contractor), and include what procedures are used to simulate conditions.

C. PVT Sample Size

1. Test all central plant equipment and primary air handling unit controllers unless otherwise directed.
2. Twenty percent sample testing is allowed for identical controllers typical of terminal control like VAV boxes and fan coil units.
3. The Engineer may require testing of like controllers beyond a statistical sample if sample controllers require retesting or do not have consistent results.
4. The Engineer may witness all testing, or random samples of PVT items. When only random samples are witnessed, the Engineer may choose which ones.

D. Pre-Performance Verification Testing Checklist

1. Submit the following as a list with items checked off once verified. Provide a detailed explanation for any items that are not completed or verified.
2. Verify all required mechanical installation work is successfully completed, and all HVAC equipment is working correctly (or will be by the time the PVT is conducted).
3. Verify all required control system components, wiring, and accessories are installed.
4. Verify the installed control system architecture matches approved drawings.
5. Verify all control circuits operate at the proper voltage and are free from grounds or faults.
6. Verify all require surge protection is installed. Verify all DDC network communications function properly, including uploading and downloading programming changes.
7. Using the BACnet protocol analyzer, verify communications are error free.
8. Verify each digital controller¢s programming is backed up.
9. Verify all wiring, components, and panels are properly labeled.
10. Verify all required points are programmed into devices.
11. Verify all TAB work affecting controls is complete.
12. Verify all valve and actuator zero and span adjustments are set properly.
13. Verify all sensor readings are accurate and calibrated.
14. Verify each control valve and actuator goes to normal position upon loss of power.
15. Verify all control loops are tuned for smooth and stable operation. View trend data where applicable.
16. Verify each controller works properly in stand-alone mode.
17. Verify all safety controls and devices function properly, including freeze protection and interfaces with building fire alarm systems.
18. Verify all electrical interlocks work properly.

19. Verify all workstations, notebooks and maintenance personnel interface tools are delivered, all system and database software is installed, and graphic pages are created for each workstation and notebook.
20. Verify the as-built (shop) control drawings are completed.

E. Conducting Performance Verification Testing

1. Conduct Engineer-witnessed PVT after approval of the PVT Plan and the completed Pre-PVT Checklist.
2. Notify the engineer of the planned PVT at least 15 days prior to testing. Provide an estimated time table required to perform the testing. Furnish personnel, equipment, instrumentation, and supplies necessary to perform all aspects of the PVT. Ensure that testing personnel are regularly employed in the testing and calibration of DDC systems. Using the project's as-built control system drawings, the project's mechanical design drawings, the approved Pre-PVT Checklist, and the approved PVT Plan, conduct the PVT.
3. During testing, identify any items that do not meet the contract requirements and if time permits, conduct immediate repairs and re-test. Otherwise, deficiencies shall be investigated, corrected, and re-tested later.
4. Document each deficiency and corrective action taken.
5. If re-testing is required, follow the procedures for the initial PVT.
6. The Engineer may require re-testing of any control system components affected by the original failed test.

F. Controller Capability and Labeling

1. Test the following for each controller:
2. Memory:
3. Demonstrate that programmed data, parameters, and trend/ alarm history collected during normal operation is not lost during power failure.

G. Direct Connect Interface:

1. 1) Demonstrate the ability to connect directly to each type of digital controller with a portable electronic device like a notebook computer.
2. Show that maintenance personnel interface tools perform as specified in the manufacturer's technical literature.

H. Stand Alone Ability:

1. Demonstrate controllers provide stable and reliable stand-alone operation using default values or other method for values normally read over the network.

I. Wiring and AC Power:

1. Demonstrate the ability to disconnect any controller safely from its power source using the AC Power Table. Demonstrate the ability to match wiring labels easily with the control drawings. Demonstrate the ability to locate a controller's location using the BACnet Communication Architecture Schematic and floor plans.

J. Nameplates and Tags:

1. Show the nameplates and tags are accurate and permanently attached to control panel doors, devices, sensors, and actuators.

K. Workstation and Software Operation

1. For every user workstation or notebook provided:
2. Show points lists agree with naming conventions.
3. Show that graphics are complete.

L. BACnet Communications and Interoperability Areas

1. Demonstrate proper interoperability of data sharing, alarm and event management, trending, scheduling, and device and network management.
2. If available or required in this specification, use a BACnet protocol analyzer to assist with identifying devices, viewing network traffic, and verifying interoperability. These requirements must be met even if there is only one manufacturer of equipment installed. Testing includes the following:

    a. Data Presentation: On each BACnet Operator Workstation, demonstrate graphic display capabilities.
    b. Reading of Any Property: Demonstrate the ability to read and display any used readable object property of any device on the network.
    c. Setpoint and Parameter Modifications: Show the ability to modify all setpoints and tuning parameters in the sequence of control or listed on project schedules. Modifications are made with BACnet messages and write services initiated by an operator using workstation graphics, or by completing a field in a menu with instructional text.
    d. Peer-to-Peer Data Exchange: Show all BACnet devices are installed and configured to perform BACnet read/write services directly (without the need for operator or workstation intervention), to implement the project sequence of operation, and to share global data.
    e. Alarm and Event Management: Show that alarms/events are installed and prioritized according to the DDC SYSTEM Owner.

PART 3 PRODUCTS

3.1 CONTROL SYSTEM

A. Manufacturers:

1.

3.2 BMS NETWORK

A. The BMS shall use the high speed Ethernet backbone independent from the owner¢s IT infrastructure. The BMS contractor shall provide all the necessary accessories on each floor level to interconnect entire facility for the DDC system including rack server and UI stations.

B. All control products provided for this project shall comprise an industry standard open protocol internetwork. Using protocols on any part of the DDC network that is proprietary to one company or distributed by one company are prohibited.

C. The system and its controllers must be fully TCP/IP or BACnet/IP compliant at the time of installation. This means that the system must use TCP/IP or BACnet/IP as the native communications protocol between distributed controllers communicating on the controller network, and must at a minimum support the BACnet Interoperability Building Blocks (BIBBs) for each IP application as specified herein.

D. The system shall meet IP communication services such that the connection of any operator interface via nay device to any one controller shall allow the operator to interface with all other controllers. The software shall provide transparent viewing and editing of all data, control programs, schedules, trends, alarms from any one controller through connection to any other controller via the IP network.

E. It shall network to all of the BACnet Application Specific Controllers (B-ASC) controlling the terminal equipment on a floor or in a system. All ASCs shall connect via a TCP/IP or BACnet/IP to the Ócore & shell• network

F. The primary BMS network shall be BACnet/IP over Ethernet. It shall network all primary IP controllers (B-BC, B-AAC), the BMS server, operator workstations (B-AWS), routers and switches.

G. The BMS server and Operator Interface shall use BACnet/IP over Ethernet and Web Technology applications over TCP/IP.

H. Systems that use variations of BACnet using PTP or MSTP between controllers, gateways, bridges or networks that are not peer-to-peer are not allowed.

I. The BMS design shall allow the co-existence of current and future primary control panels and personal computer operator workstations on the same primary network.

J. Remote Communications: Provide a TCP/IP compatible communication port for connection to the Owner¢s network for remote communications. Provide coordination with the Owner for addressing and router configuration on both ends of the remote network.

3.3 OPERATOR INTERFACE

A. BMS server: Furnish rack server to host the main software for the system. The rack server shall reside on the core & shell network.

1. Server Hardware. Windows, Linux, or purpose built appliance latest version.

    a. 19 inch rack mountable monitor.
    b. All system functionality will be available via standard web browser, Internet Explorer, Mozilla, Safari, and Chrome are to be supported at a minimum.
    c. All hardware will meet the minimum requirements of the server being provided per manufacture specifications
    d. Provide PowerEdge Dell R230 Rack Server or approved equal.

e. The rack server shall made of : Chassis with up to 2, 3.5 Cabled Hard Drives, Intel Xeon E3-1240 v6 3.7GHz, 8M cache, 4C/8T, turbo (72W), 16GB (1x16GB) 2400MT/s DDR4 ECC UDIMM, PERC H330 Integrated RAID Controller for Cabled Chassis, 2TB 7.2K RPM SATA 6Gbps 3.5in Cabled Hard Drive, On-Board LOM 1GBE Dual Port (BCM5720 GbE LOM), DVD ROM, SATA, Internal, for Cabled Chassis, 2/4 -Static Post Static Rails, NEMA 5-15P to C13 Wall Plug, 125 Volt, 15 AMP, 10 Feet, Power Cord, North America
f. Windows Server® 2016,Standard,16CORE,Factory Inst,No MED,NO CAL
g. Server and UI station must include latest version of all Microsoft Windows Office applications as well as Adobe Acrobat Standard.

2. The DDC server shall be located in the owner¢s IT rack.

B. Mobile Operator Interface: Furnish one (1) touch screen tablet computer as mobile operator interface for BMS monitoring and control. The tablet shall provide full functionality for system access, including but not limited to, animated dynamic color graphics. Provide IPad PRO with electronic pointer or pencil and heavy duty protection casing or equal.

3.4 WEB SERVER and GRAPHICAL USER INTERFACE

A. The BMS contractor shall provide system software based upon a architecture, designed around the open standards of web technology. The BMS server shall communicate using ASHRAE¢s BACnet/IP protocol, as well as all other IP protocols. Protocols not using TCP/IP are specifically excluded. Server shall be accessed using a web browser over The Owner¢s intranet and remotely over the Internet.

B. The intent of the web based architecture is to provide the operator(s) complete and secure access to the BMS system via a web browser. No special software, (active-x components or fat java clients) shall be required to be installed on the PC¢s or hand held mobile devices (e.g. smart phones, tablets) used to access the BMS via a web browser. No special server hardware shall be required.

C. The BMS server software must support at least the following server platforms (Windows and Linux). The BMS server software shall be developed and tested by the manufacturer of the system standalone controllers and network controllers/routers. Third party manufactured and developed BMS software is not acceptable.

3.5 ELECTRONIC DOCUMENTATION

A. Provide software applications and files to view documentation through the Web based interface.

B. Provide a CAD viewer to view all project AutoCAD documents that are made available by the Architect and Owner.

C. Provide all controls cut sheets in PDF format. Make them available to any user accessing the system over the Internet.

D. Provide a text version of the sequence of operation. Make the written sequence available from the graphic that represents each system. The sequence shall pop up in a printable format such as HTML or PDF.

3.6 IP EQUIPMENT

A. IP System Controllers

1. Must support TCP/IP, BACnet IP and BACnet Ethernet communications
2. Must connect directly to the provided Ethernet network via Twisted-Pair (CAT 6) cabling without the use of any external getaway or transceiver
3. Application Database can be flash loaded over the network
4. Must include all mounting hardware
5. The controller firmware must be able to be flash loaded over the network
6. Must coordinate with the owner who is providing the base building Ethernet network to to bring all system controllers onto the facilities Virtual LAN
7. Minimum 32 Bit Processor
8. Minimum 2 MB Flash Memory
9. Minimum 319 KB SRAM for Database
10. IP PoE Application Controllers
11. Must support Ethernet (10/100), BACnet IP and BACnet Ethernet communications
12. Must connect directly to the provided Ethernet network via Twisted-Pair (CAT 6) cabling without the use of any external getaway or transceiver
13. Must be Power over Ethernet (PoE IEEE 802.af-2003 or IEEE 802.at-2009)
14. Minimum 32 Bit Processor
15. Minimum 2 MB Flash Memory
16. Minimum 319 KB SRAM for Database
17. Supports firmware upgrades and database load/save over the network
18. Management will review both wired and wireless solutions (Zigby or sub gigahertz) for thermostats and sensors.
19. Must coordinate with the owner who is providing the base building Ethernet network to to bring all system controllers onto the facilities Virtual LAN

3.7 SYSTEM APPLICATION SOFTWARE

A. Provide a copy of the software (or all software if there are multiple) used to program and download sequences to controllers. Provide a backup of the all of the programs used in the system for storage by the Owner.

B. Software generation shall follow standard sequences for heat exchanger control, condensate alarming, psychometric chart control of DX systems, and reset schedules.

C. Software alarms shall be provided for analog deviation, run-time, utility services failure, space comfort range deviation, and additional alarms as directed by the Facilities Systems Engineering team.

D. Alarms shall report device location, software name, description, criticality of alarm, and the appropriate corrective action to be taken. Alarms shall report to the designated Work Stations and be logged on the alarm printer showing date and time of alarm.

E. All control software programs shall be loaded onto the hard disk drive of the Engineering Work Station. All programs shall be down loaded from this terminal to insure that the control programs in the field are identical to those on record in the Engineering Work Station.

F. The PMI (Person Machine Interface) programs, such as color graphics, summaries, reports, etc., shall be developed by the contractor, approved by Facilities team and loaded to the Engineering Work Station and controllers prior to the initial job walk-through.

G. Alarm Management

1. All alarm or point change reports shall include the point¢s English language description, and the time and date of occurrence.
2. The installer shall set up all system analog points with high and low alarm limits. All digital system points shall be associated with a status feedback point and all exceptions shall be reported as alarms. The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized and filtered to minimize nuisance reporting and to speed operator response to critical alarms.
3. The user shall also be able to define under which conditions point changes need to be acknowledged by an operator, and/or sent to follow-up files for retrieval and analysis at a later date.
4. Critical alarms shall be displayed at the designated workstations, printed at the alarm printer, and paged to the on-duty maintenance person over the owner¢s or vendor¢s paging system, as requested by the owner. Alpha pages shall provide sufficient information to identify the equipment and the point in alarm and the time and date of occurrence.
5. All other alarms shall be considered non-critical and shall be displayed and acknowledged before being sent to the alarm log.
6. Alarm reports, messages, and files shall be directed to a owner-defined list of operator devices, or devices used for archiving alarm information or reports. Alarms shall also be automatically directed to a default device in the event a primary device is found to be off-line.
7. In Dial-up applications, only critical alarms shall initiate a call to a remote operator device. In all other cases, call activity shall be minimized by time-stamping and saving reports until an operator scheduled time, a manual request is made, or until the buffer space is full. The alarm buffer must store a minimum of 50 alarms.

H. Color Graphics

1. Provide animated 3D graphics in .gif or other graphical format suitable for display in a web browser. Graphics shall include aerial building/campus views, color building floor-plans, equipment drawings, active graphic setpoint controls, web content, and other valid HTML, XML, SVG elements. The data on each graphic page shall automatically refresh at a rate defined by the operator.
2. Floor plan graphics shall show heating and cooling zones throughout the buildings in a range of colors, which provide a visual display of temperature relative to their respective setpoints.
3. Mechanical system graphics shall show the type of mechanical system components serving any zone through the use of a pictorial representation of components. Selected I/O points being controlled or monitored for each piece of equipment shall be displayed with the appropriate engineering units. Animation shall be used for rotation or moving mechanical components to enhance usability. Each piece of equipment being monitored or controlled shall be depicted including: Each piece of equipment including each terminal unit, each building, each floor and each zone.

I. Scheduling

1. Scheduling shall be accomplished by using the system geographic navigation tree. The viewer shall be able to define a Time of Day, Holiday or Event schedule for an individual piece of equipment, room, area, floor, tenant, building, campus, site, etc. For example, a new time schedule for every level in the system would be created by clicking at the top of the geographic hierarchy defined in the Navigation Tree.
2. Schedules shall comply with the BACnet standard, (Schedule Object, Calendar Object, Weekly Schedule property and Exception Schedule property) and shall allow events to be scheduled. Schedules shall have the ability to be created in the following manner: a specific date, a range of dates, any combination of month of year (1-12, any), day of week, wildcard (example, allow combinations like second Tuesday of every month).

J. Security

1. Each operator shall be required to log on to the system with a user name and 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.

K. Historical Trending and Data Collection

1. Trends shall conform to the BACnet Trend Log Object specification. The system shall be able to trend and display graphically any analog, digital or calculated points.
2. Trend Logs. The operator shall be able to define a custom trend log for any data object in the system. This definition shall include change-of-value digital, change-of-value analog, time interval, start time, and stop time. Trend data shall be sampled and stored on the DDC controller, and be uploaded and archived on the hard disk and be retrievable for use in spreadsheets and standard database programs.
3. Dynamic Data Exchange (DDE). Software shall support dynamic data sharing with other Windows-based programs for third party add-on functionality e.g. preventative maintenance, tenant billing, etc.

L. Reporting

1. The system shall have the capability to generate pre-configured or customized reports automatically or upon manual command.

M. Diagnostics

1. Provide software which allows efficient identification of unfavorable trends from the operator workstation. Provide tuning screens which shall aid the operator in tuning individual PID loops.

3.8 CONTROL PANELS

A. Select the proper panel type depending of application as follow:

1. NEMA 1 applications: general purpose for indoor protection, where conditions are not unusually severe.
2. NEMA 2 applications: drip-tight for indoor protection, designed to exclude falling moisture or dirt. Particularly applicable to cooling room, laundries etc.., where condensation is prevalent.

3. NEMA 3 applications: weather resistant (weatherproof) for outdoor use; designed to withstand all normal exposure to natural elements
4. NEMA 3R applications: rain-proof and sleet (ice) resistant for outdoor use; intended to protect enclosed equipment against rain and meet the requirements of UL 506, applying to Órain-proof enclosures• .
5. NEMA 4 applications: watertight withstands water pressure from 1 inch hose nozzle, 65 gallons per minute, from distance of not less than 10 feet for five minutes. Suitable for maritime applications, breweries, etc.
6. NEMA 4X applications: corrosion-resistant, same provisions as NEMA 4 and, in addition is corrosion-resistant.
7. NEMA 5 applications: dust-tight, equipped with dust-tight gaskets. Suitable for mills and other high-dust atmospheres.
8. NEMA 6 applications: submersible, for submerged operation under specified pressure & time.
9. NEMA 7 applications: hazardous locations, NEC class 1 (circuit breaks in air)
10. NEMA 8 applications: hazardous locations, NEC code class 1 (circuit breaks in oil)
11. NEMA 9 applications: hazardous locations, national electrical code class 2
12. NEMA 10 applications: explosion-proof meet US bureau of mines requirements for explosive atmospheres.
13. NEMA 11 applications: acid or fume resistant provides for immersion of enclosed equipment in oil
14. NEMA 12 applications: industrial use, excludes oils, dust, and moisture, to satisfy individual requirements.

B. Recommended manufacturer:

1. Unity manufacturer
2. Hoffman enclosures

C. The DDC contractor shall use double terminal blocks within a control panel for control panels, with a cognizant sequential numbering system, use different terminal block color for type of use in order to user ease identification. The control panel shall consist of (3) dedicated transformer for controllers, end devices and (1) 24v power supply for DC power devices as follow:

1. 120v power (black Ó hot, black Ó neutral, green Ó ground)

    a. Recommended Terminal block manufacturer:

        1) Automation Direct or Approved equal

2. Panel switch and receptacle assembly.
3. Transformer#1 (To be use to power all DDC controllers within control panel Ó use red double terminals top terminal - 24vac, bottom terminal Ó common)

    a. Recommended Terminal Block manufacturer: A

        1) Automation Direct or Approved equal

    b. Recommended Transformer Manufacturer:

        1) Functional devices model# TR100VA-001 with circuit breaker.

4. Transformer #2 (To be use to power valves and actuators from associated control panel, use yellow top terminal for 24vac and bottom terminal for common).

a. Recommended Terminal Block manufacturer:

1) Automation Direct or Approved equal

b. Recommended Transformer Manufacturer:

1) Functional devices model# TR100VA-001 with circuit breaker.

5. Transformer #3 (To be use for additional power for valves and actuators from associated control panel, use orange top terminal for 24vac and bottom terminal for common)

a. Recommended Terminal Block manufacturer:

1) Automation Direct or Approved equal

b. Recommended Transformer Manufacturer:

1) Functional devices model# TR100VA-001 with circuit breaker.

6. Power supply (To be use to power DC end devices Ó use blue top terminal for 24vdc and bottom terminal for common or negative)

a. Recommended Terminal Block manufacturer:

1) Automation Direct or Approved equal

b. Recommended Power Supply Manufacturer:

1) Automation Direct model# PSP24-024C with circuit breaker.

7. For End devices inputs or outputs use gray terminal top terminal for universal input signal (analog or digital) bottom terminal - universal input common (analog or digital)

a. Recommended Terminal Block manufacturer:

1) Automation Direct or Approved equal

8. Use terminal block accessories such as jumpers and terminal block number tagging.

a. Recommended jumper and tag manufacturer:

1) Automation Direct or Approved equal.

D. The DDC contractor shall submit as part of the control submittal the labelling system intended to be used in order to identify control panel per system. This labelling system shall be describe throughout the control submittal to ease identification.

E. The DDC contractor shall submit as part of the control submittal a control panel layout.

F. The DDC contractor shall labelled each control panel using engraved phenolic labels as follow:

1. Use black background, white letters.
2. Label text should be situated in the middle of the label.

3. Each word should have first letter capitalized and rest lower case.
4. Use a 5• wide x 5• high label as minimum.
5. Text size should be in commensurate with label size.

G. Each DDC control panel shall have a copy of the control submittal delineating the panel internal control wiring

H. Power wiring and communication wiring shall be provided in separate conduits with separate hot, neutral, and ground wire runs and separate breakers.

I. Coordinate installation of the control panels with the owner.

J. Coordinate power for the panels with the electrical contractor.

K. Unless otherwise noted, mounting any control devices on the back of the control panel enclosure door is not acceptable.

L. All panel wirings shall in be installed in panduit and wiring duct. This shall include but not be limited to wiring from the DDC controller to the terminal block, between DDC controller and relays (and other panel mounted control devices), power wiring for the controller and communication.

M. Only one controller shall be allowed in a control panel with expansion modules if extra points are needed then the DDC contractor shall utilize the largest controller and control panels available and if maxed out, only then can a second controller to be installed within the panel.

N. Each DDC control panel shall have a label located in the back door containing the following information:

1. Controller designated name or number
2. Building management system mac address
3. Network segment that belongs and the associated data manager or primary controller name assigned to.
4. It is not acceptable to have hand-written notes on control panel back door.

O. Each DDC control panel shall be equipped with:

1. A Perforated back panel.
2. 3/8 flange nut.
3. cylinder key lock, std 751coin lock cam
4. Metal back door pocket.

3.9 ELECTRONIC SENSORS

A. Manufactured, brand labelled or distributed by Belimo.

B. Description: Vibration and corrosion resistant with SI Protection; for wall, immersion, or duct mounting as required.

C. Enclosure shall be a color contrasting NEMA Type 4X/IP65 including a NEMA 4X/IP65 cable gland, a 1/2 NPT conduit adapter fitting a tool-free access.

D. Thermistor Temperature Sensors and Transmitters:

1. Accuracy: Plus or minus 0.3 deg F at 77 degF (25 degC).
2. Cable: Single pair shielded, plenum rated to 300 DegF (150 degC) 22AWG, tinned copper, green jacket, 300V.
3. Insertion Elements for Liquids: Single piece stainless steel thermowell pocket.

E. RTDs and Transmitters:

1. Accuracy: +/- 0.5 degF (0.3 degC) at 32 DegF (zero DegC).
2. Cable: Single pair shielded, plenum rated to 300 DegF (150 degC) 22AWG, tinned copper, green jacket, 300V.
3. PT1000 Averaging element shall incorporate a true averaging continuous sensing element throughout the length of the probe.
4. Insertion Elements for Liquids: Single piece stainless steel thermowell pocket.

F. Humidity Sensors: Capacitor sensor element.

1. Accuracy: ±2% between 10 to 90% RH at calibration point.
2. Duct Sensor: 0 to 100% relative humidity range with stainless steel wire mesh filter and adjustable rubber mounting flange.
3. Outside Air Sensor: 0 to 100% relative humidity range with mounting enclosure and detachable mounting plate suitable for operation at outdoor temperatures [Ó30 to 160 deg F (-30 to 70 deg C)]
4. Duct/Outside Air Sensor shall have selectable output for relative humidity, enthalpy, dew point or absolute humidity.
5. Duct/Outside Air Sensor shall have temperature integration with dual outputs of 0-5/10 Vdc or 4 to 20 mA.

G. Pressure Transmitters/Transducers:

1. Air Differential-Pressure Transmitter: 8 field selectable ranges.

a. Range: 0- to 1-inch wc (0 to 250 Pa)

1) Accuracy: [+/- 0.004 inch wc (1 Pa)]
2) Outputs: 0 to 5/10 VDC and 4 to 20 mA integrated into one unit.
3) Auto zero calibration.

b. Duct Air Differential-Pressure Range: 0- to 10-inch wc (0 to 2500 Pa)

1) Accuracy: 2 inch wc (498 Pa) or less [+/- 0.02 inch wc (5 Pa)]
2) Accuracy: 2 inch wc (498 Pa) to 12 inch wc (2500 Pa) [+/- 0.04 inch wc (10 Pa)]
3) Outputs: 0 to 5/10 Vdc and 4 to 20 mA integrated into one unit.

c. Duct Air Differential-Pressure Range: 0- to 28-inch wc (0 to 7000 Pa)

1) Accuracy: 8 inch wc (1991 Pa) or less [+/- 0.04 inch wc (10 Pa)]
2) Accuracy: 9 inch wc (2240 Pa) to 29 inch wc (7000 Pa) [+/- 0.1 inch wc (25 Pa)]
3) Outputs: 0 to 5/10 Vdc and 4 to 20 mA integrated into one unit.

2. Liquid Gauge Pressure Transducers: NEMA Type 4/IP65, stainless steel housing, stainless steel diaphragm construction, suitable for service; minimum double the nominal operating pressure; linear output 0 to 10 Vdc or 4 to 20 mA.
3. Liquid Differential-Pressure Transducers: NEMA Type 4/IP65 stainless steel housing, ceramic/stainless steel diaphragm construction, suitable for service; measurement range 0-15/30 psig, single sided 85 psig operating pressure and tested to 300 psig; suitable for service; measurement range 0-50-/100 psig, single sided 230 psig operating pressure and tested to 300 psig; linear output 0 to 10 vdc or 4 to 20 mA.

3.10 STATUS SENSORS

A. Status Inputs for Fans and Pumps: Current sensor measuring Amperage.

B. Status of flow Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig, piped across pump. Pumps Statuses shall include current sensing as well prove of flow.

C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

D. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.

E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.

F. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.

G. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

H. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

I. Manufacturers:

1. Veris Industries
2. Functional Devices

3.11 GAS DETECTION EQUIPMENT

A. Manufacturers:

1. Honeywell Analytics.

B. Carbon Monoxide Detectors: Single or multichannel, dual-level detectors using solid-state plug-in sensors with a 3-year minimum life; suitable over a temperature range of 32 to 104 deg F; with 2 factory-calibrated alarm levels at 50 and 100 ppm.

C. Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; suitable over a temperature range of 23 to 130 deg F (minus 5 to plus 55 deg C) and calibrated for 0 to 2 percent, with continuous or averaged reading, 4- to 20-mA output;, for wall mounting.

3.12 Accessories:

3.13 FLOW MEASURING STATIONS

A. Duct Airflow Station: It shall include probes and transmitter .

B. Fan Inlet Airflow Station: It shall include probes and transmitter

C. The DDC vendor shall be responsible to submit proper and applicable size for each application through an airflow station schedule along with the selected model number of all associated components.

1. Manufacturers:

a. EBTRON.

3.14 STATUS AND SAFETY SWITCHES

A. All safety switches shall have 2 contacts, one for interlock to device, one for DDC input.

3.15 THERMOSTATS

A. Manufacturers:

1. Johnson Controls.
2. Approved equal

B. Combination Thermostat and Fan Switches: Line-voltage thermostat with push-button or lever-operated fan switch.

1. Label switches "FAN ON-OFF" or as required.
2. Mount on single electric switch box.

C. Electric, solid-state, microcomputer-based room thermostat with remote sensor.

1. Automatic switching from heating to cooling.
2. Preferential rate control to minimize overshoot and deviation from set point.
3. Set up for four separate temperatures per day.
4. Instant override of set point for continuous or timed period from 1 hour to 31 days.
5. Short-cycle protection.
6. Programming based on weekday, Saturday, and Sunday.

7. Selection features include degree F or degree C display, 12- or 24-hour clock, keyboard disable, remote sensor, and fan on-auto.
8. Battery replacement without program loss.
9. Thermostat display features include the following:

    a. Time of day.
    b. Actual room temperature.
    c. Programmed temperature.
    d. Programmed time.
    e. Duration of timed override.
    f. Day of week.
    g. System mode indications include "heating," "off," "fan auto," and "fan on."

D. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.

E. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.

1. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.
2. Selector Switch: Integral, manual on-off-auto.

F. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature; with copper capillary and bulb, unless otherwise indicated.

1. Bulbs in water lines with separate wells of same material as bulb.
2. Bulbs in air ducts with flanges and shields.
3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.
4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
5. On-Off Thermostat: With precision snap switches and with electrical ratings required by application.
6. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.

G. Fire-Protection Thermostats: Listed and labeled by an NRTL acceptable to authorities having jurisdiction; with fixed or adjustable settings to operate at not less than 75 deg F above normal maximum operating temperature, and the following:

1. Reset: Manual.
2. Reset: Automatic, with control circuit arranged to require manual reset at central control panel; with pilot light and reset switch on panel labeled to indicate operation.

H. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.

I. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type; with adjustable set point in middle of range, adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.

J. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic- reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.

1. Bulb Length: Minimum 20 feet.
2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

K. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic- reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above set point.

1. Bulb Length: Minimum 20 feet.
2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

L. Heating/Cooling Valve-Top Thermostats: Proportional acting for proportional flow, with molded-rubber diaphragm, remote-bulb liquid-filled element, direct and reverse acting at minimum shutoff pressure of 25 psig, and cast housing with position indicator and adjusting knob.

3.16 HUMIDISTATS

A. Manufacturers:

1. MAMAC Systems, Inc.
2. Veris Industries.
3. ACI

B. Duct-Mounting Humidistats: Electric insertion, 2-position type with adjustable, 2 percent throttling range, 20 to 80 percent operating range, and single- or double-pole contacts.

3.17 VARIABLE FREQUENCY DRIVES

A. Refer to VFD section of the performance specification for VFD performance.

B. Serial Interface: RS-485 Communications interface to DDC Systems:

1. The VFD shall interface to the DDC system through a serial communications port, which shall allow the DDC system to control speed, start/stop, set PID parameters, limit current, and accel, decal time adjustments. DDC shall monitor through the interface: output speed, current, % torque, power, kWh, operating hours, alarms

C. All VFDs to be wired over BACnet/MSTP for monitoring purposes only, no control.

D. All VFDs to be controlled via hard-wired inputs and outputs.

3.18 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.

1. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
4. Spring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.
5. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

1. Manufacturers:

    a. Belimo Aircontrols (USA), Inc.

2. The position of actuators serving some systems must be monitored with analog points. Monitor the position of all actuators with analog points. Waiver of this requirement may be allowed by the facility Systems Engineer when the device is in close proximity to the controlled device, ie a coil discharge temperature sensor.

    a. Actuators used on the following equipment and systems require monitoring with analog points:
    b. Air Handling Units
    c. Dampers serving Air Handling Units
    d. VAVs with reheat
    e. Heat exchangers
    f. Actuators used on the following equipment and systems do not require monitoring with analog points:
    g. Fan Coil Units
    h. Dampers not serving Air Handling Units

3. Valves: Size for torque required for valve close off at maximum pump differential pressure.
4. Dampers: Size for running torque calculated as follows:

    a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. (86.8 kg-cm/sq. m) of damper.
    b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. (62 kg-cm/sq. m) of damper.
    c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft (49.6 kg-cm/sq. m) of damper.
    d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. (37.2 kg-cm/sq. m) of damper.
    e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.

f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.

5. Coupling: V-bolt and V-shaped, toothed cradle.
6. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
7. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.
8. Power Requirements (Two-Position Spring Return): 24-V ac.
9. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
10. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
11. Temperature Rating: Minus 22 to plus 122 deg F (Minus 30 to plus 50 deg C).
12. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F (Minus 30 to plus 121 deg C).
13. Run Time: 12 seconds open, 5 seconds closed.

3.19 CONTROL VALVES

A. Manufacturers:

1. Belimo.

B. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

C. Hydronic system globe valves shall have the following characteristics:

1. NPS 2 and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.
2. NPS 2-1/2 and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
3. Internal Construction: Replaceable plugs and stainless-steel or brass seats.

    a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
    b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.

4. Sizing: 3-psig maximum pressure drop at design flow rate or the following:

    a. Two Position: Line size.
    b. Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
    c. Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.

5. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

D. Butterfly Valves: 200-psig, 150-psig maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.

1. Body Style: Wafer.
2. Disc Type: Aluminum bronze.
3. Sizing: 1-psig maximum pressure drop at design flow rate.

E. Terminal Unit Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.

1. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.
2. Sizing: 3-psig maximum pressure drop at design flow rate, to close against pump shutoff head.
3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

F. Self-Contained Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.

1. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.
2. Thermostatic Operator: Liquid-filled remote sensor with remote adjustable dial.

3.20 24VAC POWER DISTRIBUTION PANELS

A. There shall be 24VAC power distribution panels to feed VAV boxes and associated end devices low voltage power load.

B. The 24VAC power distribution panels not to exceed from 5 24VAC power loops.

C. Each power loop shall feed a maximum of 4 control devices only or 80% power consumption load from each transformer maximum capacity.

D. Use Proper gauge wire for each low voltage power loop.

E. Follow local and natioanl standard electrical codes.

F. Manufacturers:

1. Functional Devices: PSH500A - 480/277/240/120 VAC to 24VAC, five 100VA outputs with enclosure.

END OF SECTION 230900

SECTION 230993.11 - SEQUENCE OF OPERATIONS FOR HVAC DDC

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 control sequences for DDC for HVAC systems, subsystems, and equipment.

1.3 DEFINITIONS

A. Analog Output: Proportional output signal (zero- to 10-V dc, 4 to 20 mA).

B. Binary Output: On/off output signal or contact closure.

C. DDC: Direct digital control.

D. Digital Output: Data output that must be interpreted digitally.

PRODUCTS (Not Applicable)

PART 2 EXECUTION (Not Applicable)

END OF SECTION 230993.11

SECTION 232300 - REFRIGERANT PIPING

1.1 PERFORMANCE REQUIREMENTS

A. Quality Standards: ASHRAE 15 and ASME B31.5.

1.2 PRODUCTS

A. Copper Tube and Fittings: Type K or L.

B. Valves and Specialties:

1. Diaphragm packless valves.
2. Packed-angle valves.
3. Check valves.
4. Service valves.
5. Solenoid Valves: 24 -V ac.
6. Safety relief valves.
7. Thermostatic expansion valves for 40 deg F suction temperature; adjustable superheat.
8. Angle-type strainers.
9. Moisture/liquid indicators.

1.3 REFRIGERANTS

A. R-410A.

1.4 PIPING APPLICATION SCHEDULES

A. Piping Applications for Refrigerant R-410A: Maximum NPS 4.

1. Suction Lines for Conventional Air-Conditioning Applications: Copper.
2. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications:

    a. NPS 2 and Smaller: Copper with brazed joints.
    b. NPS 2-1/2 and Larger: Schedule 40, black steel with welded joints.

3. Safety-Relief-Valve Discharge Piping:

    a. NPS 2 and Smaller: Copper with brazed joints.

END OF SECTION 232300

SECTION 233113 - METAL DUCTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

B. No part of the Contract Documents exists in isolation. Recitations of requirements relevant to one vendor, prime contractor, subcontractor or trade may exist in multiple sections. Failure to reference or review the relevant information within the complete Contract Documents shall not grant relief from any provision of the Contract Documents.

C. If these Contract Documents are incompletely delivered, immediately request a complete set. If a complete set is not delivered upon request, the contract holder that failed to provide the complete set as requested (that is the Owner, General Contractor, and Construction Manager as applicable) shall remain responsible for providing scope that was not priced because the scope was noted on an element of the Contract Documents not made available as requested.

D. Technical standards and codes are referenced within this document. Where a standard is referenced, all work and products described within this section that are covered within the scope of the referenced standard shall comply with the applicable requirements of the referenced standard. The applicable requirements of referenced standards are incorporated into this document by reference.

1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Double-wall rectangular ducts and fittings.
3. Single-wall round and flat-oval ducts and fittings.
4. Double-wall round and flat-oval ducts and fittings.
5. Sheet metal materials.
6. Duct liner.
7. Sealants and gaskets.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.
3. Seismic-restraint devices.

B. Sustainable Design Submittals:

1. Product Data: For ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Product Data: For adhesives, indicating VOC content.
3. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
4. Product Data: For sealants, indicating VOC content.
5. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

C. Delegated-Design Submittal:

1. Schedule of sheet metal thicknesses for use on the project. Designations used in shop standards shall be used in shop drawings.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Attachments of linings including nosings.
5. Details of fitting construction.
6. Materials, fabrication, assembly, and spacing of hangers and supports.

D. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Shop drawings shall clearly show locations of all fire and smoke rated assemblies, security perimeters, EMI/RFI shielding (nuclear magnetic resonance, magnetic resonance imaging, sensitive electronics rooms), and xray shielding.
3. Factory- and shop-fabricated ducts and fittings.
4. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
5. Elevation of bottom and tops of ducts.
6. Dimensions of main duct runs from building grid lines.
7. Fittings.
8. Reinforcement and spacing.
9. Seam and joint construction type.
10. Penetrations through fire-rated and other partitions.
11. Equipment installation based on equipment being used on Project.
12. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
13. Hangers and supports, including methods for duct and building attachment and vibration isolation.
14. Note static pressure loss for any unapproved fitting type. See Delegated Design submittal requirements.
15. Note duct velocity between each connection, for each duct size

16. Note duct flow between each connection, for each duct size

E. Quality Control Submittals

1. Duct leakage testing protocol.
2. Duct leakage testing reports.

    a. Test results
    b. Remediation undertaken to resolve unacceptable test results.
    c. Retest results.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
    f. Perimeter moldings.
    g. Suspended artwork, sculpture or structures.

7. Documented sign off by all trades and construction manager prior to fabrication of each area.

B. Welding certificates.

C. Field quality-control reports other than leakage testing.

1.6 QUALITY ASSURANCE

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

PART 2 PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Only a subset of the constructions described within these standards are permissible on this project. Please reference the schedules within the execution part of this section for applicability.

2.2 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. Rectangular Ducts: Fabricate ducts with indicated dimensions for the inner duct.

B. Outer Duct: Comply with requirements for single walled duct.

C. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C 534, Type II for sheet materials, and with NFPA 90A or NFPA 90B.

D. Inner Duct: Minimum 0.028-inch perforated galvanized sheet steel having 3/32-inch- diameter perforations, with overall open area of 23 percent.

E. Formed-on Transverse Joints (Flanges): Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Traverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

F. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 30 inch in Diameter: Flanged.

D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.4 DOUBLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.

B. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.

1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Inner Duct: Minimum 0.028-inch perforated galvanized sheet steel having 3/32-inch- diameter perforations, with overall open area of 23 percent.

D. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C 534, Type II for sheet materials, and with NFPA 90A or NFPA 90B.

2.5 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

2.6 DUCT LINER

A. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Aeroflex USA, Inc.
b. Armacell LLC.

2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

a. Adhesive shall have a VOC content of 80 g/L or less.

B. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

    a. Fan discharges.
    b. Intervals of lined duct preceding unlined duct.
    c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.

    a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.

10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.7 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.

9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. Sealant shall have a VOC content of 420 g/L or less.
7. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.8 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 , "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

C. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

D. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

E. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

G. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

1. Drawings show the general layout of ductwork and accessories but do not show all required fittings and offsets that may be necessary to connect ducts to equipment, boxes, diffusers, grilles, etc., and to coordinate with other trades. Fabricate ductwork based on field measurements. Provide all necessary fittings and offsets at no additional cost. Coordinate with other trades for space available and relative location of HVAC equipment and accessories. Duct sizes on the drawings are inside dimensions which shall be altered by Contractor to other dimensions with the same air handling characteristics where necessary to avoid interferences and clearance difficulties.
2. 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.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round and flat-oval ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through elevator machine rooms, transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through rated interior partitions, floor slabs, roofs, and exterior walls, install fire dampers, smoke dampers, and combination fire-smoke dampers as required. Comply with requirements in Section 233300 "Air Duct Accessories" for dampers.

L. Where ducts are located within a rated ceiling/floor or ceiling/roof assembly, provide ceiling radiation dampers at ceiling penetrations for air outlets. Provide fire dampers, smoke dampers, and combination fire-smoke dampers as required when passing from within a rated ceiling/floor or ceiling/roof assembly into a shaft enclosure or exiting the rated horizontal assembly other than through a ceiling mounted air outlet.

M. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Spiral lock seams shall be oriented the same way and aligned from one section to the next for round ductwork.

F. Pieces within a single room shall be fabricated from material of the same manufacturing batch.

G. Cross beading is not permitted. Cross breaking shall be used.

H. All longitudinal and transverse joints shall be constructed using the same system for all exposed ducts. Do not mix transverse joint types. For example, if some ducts require flanged, all ducts shall be flanged.

I. Flanged connection types shall be required for ducts which pass through to other spaces. The presence of such exposed ducts shall require all ducts within the space to be flanged for visual consistency.

J. Only ductwork which terminates in the space is permitted to use connection types T-1, T-5, and T-6.

K. Ductwork pieces shall be of consistent length. No more than one piece per straight run of each size may have a different length than all other pieces.

L. Elbows and tees shall have identical straight lengths leading into and out of the fitting.

M. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Unless more stringent standards are indicated elsewhere in this section, seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Outdoor, Exhaust Ducts: Seal Class C.
4. Outdoor, Return-Air Ducts: Seal Class C.
5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wgand Lower: Seal Class B.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class C.
8. Unconditioned Space, Return-Air Ducts: Seal Class B.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wgand Lower: Seal Class C.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class C.
13. Exhaust ducts conveying Class 2 or more contaminated air under more than 0.5-Inch wgpositive pressure located indoors: Seal Class A
14. Exhaust ducts conveying Class 3 or more contaminated air under positive, negative or neutral pressure: Seal Class A.

C. Schedule of sealing required according to SMACNA Seal classes:

1. Transverse joints, splits, pants, nests, and taps: Seal classes A, B and C. All ducts on this project
2. Longitudinal joints: Seal classes A and B.
3. Penetrations of duct wall such as those for sensors, sensor cable, probes, balancing taps, and fasteners which penetrate the duct wall: Seal class A only.
4. Seal class A shall apply to all systems constructed 4-Inch wgand higher and any lower pressure class systems noted elsewhere
5. Seal class B shall apply to all systems constructed 3-Inch wgand higher and any lower pressure class systems noted elsewhere
6. Seal class C shall apply to all systems where a higher seal class is not specified elsewhere.
7. Unsealed ducts are not permitted.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inchesthick.
4. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inchesof each elbow and within 48 inchesof each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

1. Space hangers at equal distances within a single room. Reduce spacing from SMACNA maximums to maintain equal spacing and alignment with other visual features.
2. Note location of all hangers exposed to view on shop drawings.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer.

B. Paint internal pin-type fasteners for any internal linings for linear diffusers, sidewall grilles and other air outlets which allow sight lines into connected ductwork.

C. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Where tests fail on the first area required to be tested (if less than 100% of the system), an additional 25% of duct area shall be tested. If the additional area tested fails, the entire duct system shall be tested.

3. Use portable high pressure blower and necessary, calibrated airflow measuring instruments to indicate amount of leakage. Measurement instruments for flow shall have less than 3% error for the values measured. Reference testing and balancing specification.
4. Test the following systems where they are constructed to the noted pressure class or a higher class. Where multiple descriptions within this schedule are applicable, the most stringent of the conflicting provisions shall be applicable.

    a. Code minimum : all ducts 3-Inch wgor greater initially test 25% of duct area.
    b. Supply ducts (conditioned air): 2-Inch wg or greater initially test 25% of duct area.
    c. Return ducts: 2-Inch wg or greater initially test 25% of duct area.
    d. Negatively pressurized exhaust ducts (Class 1 or Class 2 air): 2-Inch wg or greater initially test50 % of duct area.
    e. Negatively pressurized outside air intake ducts: 2-Inch wg or greater initially test 25 % of duct area.
    f. Positively pressurized outside air intake ducts: 2-Inch wg or greater initially test 50% of duct area.
    g. Duct systems in excess of 150 feet in critical branch length: all pressure classes initially test 100% of duct area.

5. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
6. Ducts may not be concealed by insulation, lagging, other construction or services until they pass leakage tests.

    a. Contractor need not wait for approval of leakage testing reports which indicate passing results to conceal ductwork, which has passed the required tests.
    b. Contractor may not conceal any ductwork for which test results indicate non-compliance.
    c. Constructions which conceal ducts that do not pass tests shall be removed and replaced at contractor’s sole cost to facilitate retesting and remediation of non-conforming ductwork.

7. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test entire duct system at the appropriate pressure for the equipment design external static pressure or duct pressure class. Do not pressurize systems above the maximum allowable for the duct construction.
8. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

    a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.8 DUCT CLEANING

A. Clean new and existing duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clearly mark the positions of balancing dampers and concealed pattern controllers before cleaning, photograph the position of pattern controllers exposed to view. Positions of exposed balancing dampers shall be marked on paper taped to the damper quadrant which can be cleanly removed. Restore to their marked position following completion. Following cleaning the system shall operate as it was prior to cleaning but for the lack of foreign matter removed.

E. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

F. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.

4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.9 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.10 DUCT SCHEDULE

A. Notes:

1. Where conflicting provisions exist, the most stringent provisions from each category applicable to the project condition shall be the requirement.
2. The leakage class numbers refer to the maximum permitted leakage in cfm per 100 square feet.
3. The seal class refers to the sealing requirements of the Duct Sealing article within this section.
4. The pressure class refers to the minimum positive or negative (as applicable) pressure class for the system type and duct service. No ducts may be constructed to a pressure class less than the design external static pressure for the associated equipment even if a lower minimum pressure class is noted for the application.

B. Duct construction schedule.

1. Minimum requirements for all ducts per code:

    a. Comply with the duct construction and testing requirements of chapters 5 and 6 of mechanical code and ASHRAE 62.1.
    b. Comply with ASHRAE 90.1-2010

2. Any duct constructed to a pressure class of class of 3 inch wgor higher

    a. Minimum SMACNA Seal Class: B.
    b. Maximum SMACNA Leakage Class for Rectangular: 12.
    c. Maximum SMACNA Leakage Class for Round and Flat Oval: 12.

3. Ducts designed to operate at more than 2000 FPM

    a. Pressure Class: 4 inch wg
    b. Minimum SMACNA Seal Class: A
    c. SMACNA Leakage Class for Rectangular: 6.
    d. SMACNA Leakage Class for Round and Flat Oval: 3.

4. Ducts conveying more than 10000 CFM

    a. Pressure Class: 3 inch wg
    b. Minimum SMACNA Seal Class: B
    c. SMACNA Leakage Class for Rectangular: 12.
    d. SMACNA Leakage Class for Round and Flat Oval: 12.

5. Supply and return air ducts connected between fan coil units, furnaces, heat pumps and air terminal units and supply and return grilles.

    a. Pressure Class: 1-inch wg.
    b. Minimum SMACNA Seal Class: C.
    c. SMACNA Leakage Class for Rectangular: 24.
    d. SMACNA Leakage Class for Round and Flat Oval: 24.
    e. Galvanized steel.

6. Ducts connected to VAV and pressure controlled CAV air handling systems between air flow control devices and fans or air handlers.

    a. Pressure Class: 2 inch wg.
    b. Minimum SMACNA Seal Class: B.
    c. SMACNA Leakage Class for Rectangular: 6.
    d. SMACNA Leakage Class for Round and Flat Oval: 6.
    e. Galvanized steel.

7. Ducts connected between spaces and constant speed fan systems.

    a. Pressure Class: 2 inch wg.
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 6.
    d. SMACNA Leakage Class for Round and Flat Oval: 6.
    e. Galvanized steel.

8. Negatively pressurized exhaust ducts (Class 1 or Class 2 air and car parks)

    a. Pressure Class: 2 inch wg
    b. Minimum SMACNA Seal Class: A
    c. SMACNA Leakage Class for Rectangular: 12.
    d. SMACNA Leakage Class for Round and Flat Oval: 12.
    e. Galvanized steel

9. Negatively pressurized outside air intake ducts. (Unconditioned.)

    a. Pressure Class: 2 inch wg
    b. Minimum SMACNA Seal Class: [A] [B] [C]
    c. SMACNA Leakage Class for Rectangular: [12] [24] <Insert value>.
    d. SMACNA Leakage Class for Round and Flat Oval: [12] [24] <Insert value>.
    e. Galvanized Steel

10. Positively pressurized outside air intake ducts. (Unconditioned.)

    a. Pressure Class: [2 inch wg] [3 inch wg][4 inch wg]

b. Minimum SMACNA Seal Class: A
c. SMACNA Leakage Class for Rectangular: 6.
d. SMACNA Leakage Class for Round and Flat Oval: 6.
e. Galvanized Steel

C. Transverse Joints

1. The following flanged transverse joints are permitted. All others noted within the SMACNA standard are prohibited from use on this project.

a. Type T-22 companion flanges and gaskets.

2. At fire dampers, fire smoke dampers and smoke dampers

a. T-24, T-25 shall use plastic clips and bolts unless otherwise approved by the listing of the damper
b. T-5 and T-6 shall not exceed the quantity of screws per side and total permitted by the listing of the damper.
c. The following are prohibited

1) T-1 is prohibited.
2) T-24a is prohibited

D. Longitudinal Joints

1. The following longitudinal seams are permitted. All others noted within the SMACNA standard are prohibited from use on this project.

a. L-1 “Pittsburgh Lock” with sealant, minimum 3/8 in pocket depth
b. L-3 “Pipe Lock” with sealant, minimum 1/2 inpocket depth
c. L-4 “Standing Seam” with sealant.

E. Cross Breaking or Beading

1. Cross break or cross bead duct sides 20 inchesand larger and 0.036 inchthick or less, with more than 10 sq. ft.of nonbraced panel area.
2. Exposed ducts and fittings shall be cross broken only. Cross beading is unacceptable due to visually unappealing patterns on fittings and ducts running in different directions.

F. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.
2. PVC-Coated Ducts:

a. Exposed to Airstream: Match duct material.
b. Not Exposed to Airstream: Match duct material.

3. Stainless-Steel Ducts:

a. Exposed to Airstream: Match duct material.
b. Not Exposed to Airstream: Match duct material.

4. Aluminum Ducts: Aluminum.

G. Liner:

1. Install liner in all exposed single wall duct conveying heated or cooled air accordance with the insulation requirements of 230713 and

   a. In return ducts within [5 ft] [10 ft] [15 ft] [20 ft] [33 ft] of equipment or fan inlets.
   b. In supply ducts within [5 ft] [10 ft] [15 ft] [20 ft] [33 ft] of equipment or fan discharges.
   c. In supply ducts within [5 ft] [10 ft] [15 ft] of VAV box discharges.
   d. In branch ductwork from risers operating in excess of [1500 FPM] [2000 FPM] within [5 ft] [10 ft] [15 ft] of the branch connection.
   e. In all transfer ductwork.
   f. In all diffuser plenums.

2. Install liner with the following thicknesses. Thicknesses may be increased to achieve insulation performance required per 230713 entirely with liner.

   a. Ducts supplying or exhausting wet air (shower/toilet exhausts, dishwasher exhausts, pools, humidification systems) shall not be lined.
   b. Supply Air Ducts: [Fibrous glass, Type I] [Flexible elastomeric] [Natural fiber], [1 inch] [1-1/2 inches] [2 inches] <Insert thickness> thick.
   c. Return Air Ducts: [Fibrous glass, Type I] [Flexible elastomeric] [Natural fiber], [1 inch] [1-1/2 inches] [2 inches] <Insert thickness> thick.
   d. Exhaust Air Ducts: [Fibrous glass, Type I] [Flexible elastomeric] [Natural fiber], [1 inch] <Insert thickness> thick.
   e. Supply Fan Plenums: [Fibrous glass, Type II] [Flexible elastomeric] [Natural fiber], [1 inch] [1-1/2 inches] [2 inches] <Insert thickness> thick.
   f. Return- and Exhaust-Fan Plenums: [Fibrous glass, Type II] [Flexible elastomeric] [Natural fiber], [2 inches] <Insert thickness> thick.
   g. Transfer Ducts: [Fibrous glass, Type I] [Flexible elastomeric] [Natural fiber], [1 inch] [1-1/2 inches] [2 inches] <Insert thickness> thick.

H. Double-Wall Duct Interstitial Insulation. Thicknesses shall be the larger of the value noted below and the insulation performance required per 230713 entirely with liner. .

1. Supply Air Ducts: [1 inch] [1-1/2 inches] [2 inches] <Insert thickness> thick.
2. Return Air Ducts: [1 inch] [1-1/2 inches] [2 inches] <Insert thickness> thick.
3. Exhaust Air Ducts: [1 inch] [1-1/2 inches] [2 inches] <Insert thickness> thick.

I. Permissible Fittings for Rectangular Ducts

1. The following fittings are permitted with reference to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible,".

   a. Type RE-3 according to Figure 4-2, radiused elbow with splitter vanes according to chart 4-1.
   b. 45° lead in round taps according to Figure 4-6
   c. Concentric, eccentric and bellmouthed transitions according to Figure 4-7

2. The following fittings are permitted with applicability limits as noted

a. Type RE-2 according to Figure 4-2, 90° mitered elbow with double thickness vanes according to Figures 4-3 and 4-4 may be used when all of the following conditions are met

1) A minimum duct width of [8 in] [10 in] [12 in] and minimum height of [6 in] [8 in]. The intent is to avoid relying on the theoretical benefits of turning vanes where the duct is too small to correctly install a sufficient number of vanes.
2) Maximum vane height shall be 36 in. Use intermediate baffles to support multiple tiers of vanes for taller elbows.
3) Elbows less than 18 in wide shall use smaller vane sizes.
4) The velocity is less than 2000 FPM
5) In acoustically lined ducts turning vanes shall be formed from perforated metal 2 gages lower (thicker metal) filled with acoustically absorbent material.

b. 45° boot taps according to Figure 4-6 may be used when all of the following conditions are met

1) The diverging flow is less than 30% of the main flow
2) The main velocity is less than 1500 FPM,
3) The branch is not the critical branch
4) The boot depth must be at least 25% of the branch duct width according to the figure.
5) The intent is to limit boot taps to lower velocity systems where using a lower resistance, but more difficult to fabricate fitting will not impact the static pressure requirements for the fan.

c. Obstruction avoidance Figure C according to Figure 4-8 may be used where all of the following conditions are met

1) Velocity is less than 1200 FPM
2) No fittings are within three (3) times the duct height H downstream,
3) The height reduction to clear the obstruction is no more than 20% of the duct height H

d. Angled offset Type 1 according to Figure 4-7 may be used when all of the following conditions are met

1) Velocity is less than 1200 FPM
2) The offset distance is less than 20% of the duct width
3) The offset angle is less than 15°
4) There are no fittings within three times the duct width downstream of the offset.

e. Where velocity is less than 1200 FPMconical and bellmouth round taps according to Figure 4-6 are permitted.

3. No other fittings may be used without clearly annotating the pressure drop associated with the fitting and any system effects due to the configuration of nearby fittings and ductwork on sheetmetal shop drawings and submitting backup calculations with sheetmetal shop drawings.

J. Permissible Fittings for Round and Flat Oval

1. The following fittings are permitted with reference to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible,". A minimum of 1.5 diameter to radius ratio shall be used.

   a. Stamped elbow according Figure 3-4
   b. Up to 12 in [welded] [standing seam or welded according to duct construction requirements] segmented elbows according to Figure 3-4 with minimum 5 segments for 90° turn, 3 segments for 45° turn and minimum 1.5 radius to diameter ratio
   c. Larger than 12 in [welded] [standing seam or welded according to duct construction requirements] segmented elbows according to Figure 3-4 with minimum 5 segments and minimum 1.5 radius to diameter ratio
   d. Adjustable segmented elbows for round ducts up to [6 in] [8 in] diameter and less than 1500 fpm.

2. Taps: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

   a. Velocity 1500 fpm or Lower: Conical tap.
   b. Velocity 1500 fpm or Higher: 45-degree lateral.
   c. Conical wye.

K. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

   a. Rectangular Main to Rectangular Branch: 45-degree entry.
   b. Rectangular Main to Round Branch: Spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

   a. Velocity 1000 fpm or Lower: 90-degree tap.
   b. Velocity 1000 to 1500 fpm: Conical tap.
   c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

SECTION 233300 - AIR DUCT ACCESSORIES

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:

1. Manual volume dampers.
2. Fire dampers.
3. Combination fire and smoke dampers.
4. Duct-mounted access doors.
5. Flexible connectors.
6. Duct accessory hardware.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: [G60] [G90].

2.3 MANUAL VOLUME DAMPERS

A. Low-Leakage, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Nailor Industries Inc.
b. Ruskin Company.

2. Comply with AMCA 500-D testing for damper rating.
3. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
4. Suitable for horizontal or vertical applications.
5. Frames:

a. Hat shaped.
b. 0.094-inch- thick, galvanized sheet steel.
c. Mitered and welded corners.
d. Flanges for attaching to walls and flangeless frames for installing in ducts.

6. Blades:

a. Multiple or single blade.
b. Parallel- or opposed-blade design.
c. Stiffen damper blades for stability.
d. Galvanized, roll-formed steel, 0.064 inch thick.

7. Blade Axles: Galvanized steel.
8. Bearings:

a. Oil-impregnated bronze.
b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

9. Blade Seals: Neoprene.
10. Jamb Seals: Cambered stainless steel.
11. Tie Bars and Brackets: Galvanized steel.
12. Accessories:

a. Include locking device to hold single-blade dampers in a fixed position without vibration.

B. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.4 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Greenheck Fan Corporation.
2. Ruskin Company.

B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

D. Fire Rating: 1-1/2 hours.

E. Frame: Curtain type with blades inside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

I. Heat-Responsive Device: , replaceable link and switch package, factory installed, rated.

2.5 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

1. Greenheck Fan Corporation.
2. Ruskin Company.

B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

D. Fire Rating: 1-1/2 hours.

E. Heat-Responsive Device: Electric resettable and switch package, factory installed, rated.

F. Smoke Detector: Integral, factory wired for single-point connection.

G. Rated pressure and velocity to exceed design airflow conditions.

H. Mounting Sleeve: Factory-installed, 0.05-inch- thick, galvanized sheet steel; length to suit wall or floor application.

I. Master control panel for use in dynamic smoke-management systems.

J. Damper Motors: two-position action.

K. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
7. Electrical Connection: 115 V, single phase, 60 Hz.

L. Accessories:

1. Auxiliary switches for signaling or position indication.
2. Test and reset switches, remote mounted.

2.6 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Greenheck Fan Corporation.
2. Nailor Industries Inc.

B. Pressure Relief Access Door:

1. Door and Frame Material: Galvanized sheet steel.
2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.
3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.

4. Factory set at 3.0- to 8.0-inch wg.
5. Doors close when pressures are within set-point range.
6. Hinge: Continuous piano.
7. Latches: Cam.
8. Seal: Neoprene or foam rubber.
9. Insulation Fill: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.7 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Duro Dyne Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

2.8 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Compliance with ASHRAE/IESNA 90.1-2004 includes Section 6.4.3.3.3 - "Shutoff Damper Controls," restricts the use of backdraft dampers, and requires control dampers for certain applications. Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire and smoke dampers according to UL listing.

H. Connect ducts to duct silencers with flexible duct connectors.

I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
2. Upstream and downstream from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7. At each change in direction and at maximum 50-foot spacing.
8. Upstream and downstream from turning vanes.
9. Upstream or downstream from duct silencers.
10. Control devices requiring inspection.
11. Elsewhere as indicated.

J. Install access doors with swing against duct static pressure.

K. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.
3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.
6. Body plus Ladder Access: 25 by 17 inches.

L. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

M. Install flexible connectors to connect ducts to equipment.

N. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

O. Connect terminal units to supply ducts directly or with maximum 2-inch lengths of flexible duct. Do not use flexible ducts to change directions.

P. Connect diffusers or light troffer boots to ducts[directly or] with maximum 60-inch lengths of flexible duct clamped or strapped in place.

Q. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.

R. Install duct test holes where required for testing and balancing purposes.

S. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300

SECTION 233423 - HVAC POWER VENTILATORS

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:

1. In-line centrifugal fans.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material thickness and finishes, including color charts.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

1.4 COORDINATION

A. Coordinate size and location of structural-steel support members.

PART 2 PRODUCTS

2.1 IN-LINE CENTRIFUGAL FANS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Greenheck Fan Corporation.
2. Loren Cook Company.
3. PennBarry.

B. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

C. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing; with wheel, inlet cone, and motor on swing-out service door.

D. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.

E. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Companion Flanges: For inlet and outlet duct connections.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Enclosure Type: Totally enclosed, fan cooled.

2.3 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Equipment Mounting:

1. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

C. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch.

D. Install units with clearances for service and maintenance.

E. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

3.4 ADJUSTING

A. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

B. Replace fan and motor pulleys as required to achieve design airflow.

C. Lubricate bearings.

END OF SECTION 233423

SECTION 233600 - AIR TERMINAL UNITS

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:

1. Modulating, single-duct air terminal units.
2. Balancing terminal units.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of air terminal unit.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for air terminal units.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
3. Product data showing compliance with ASHRAE 62.1.

C. Shop Drawings: For air terminal units.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Size and location of initial access modules for acoustic tile.
3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Instructions for resetting minimum and maximum air volumes.
b. Instructions for adjusting software set points.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

A. 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.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

C. ASHRAE Compliance: Applicable requirements in ASHRAE/IES 90.1, "Section 6 - Heating, Ventilating, and Air Conditioning."

2.2 MODULATING, SINGLE-DUCT AIR TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Titus.
2. Trane.
3. Price

B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

C. Casing: 0.040-inch- thick galvanized steel, single wall.

1. Casing Liner: Comply with requirements in "Casing Liner" Article for [fibrous-glass] [flexible elastomeric] duct liner.
2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
3. Air Outlet: S-slip and drive connections[, size matching inlet size].
4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Regulator Assembly: System-air-powered bellows section incorporating polypropylene bellows for volume regulation and thermostatic control. Bellows shall operate at temperatures from zero to 140 deg F, shall be impervious to moisture and fungus, shall be suitable for 10-inch wg static pressure, and shall be factory tested for leaks.

E. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: AHRI 880 rated, [2] percent of nominal airflow at 3-inch wg inlet static pressure.
2. Damper Position: Normally closed.

F. Attenuator Section: [0.034-inch steel] [0.032-inch aluminum] sheet.

1. Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for flexible elastomeric duct liner.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

G. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware. Provide electric-resistance heating coils for air terminal units scheduled on Drawings.

1. SCR controlled.
2. Access door interlocked disconnect switch.
3. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).
4. Nickel chrome 80/20 heating elements.
5. Airflow switch for proof of airflow.
6. Fan interlock contacts.
7. Fuses in terminal box for overcurrent protection (for coils more than 48 A).

H. Controls:

1. Suitable for operation with duct pressures between 0.25- and 3.0-inch wg inlet static pressure.

2.3 CASING LINER

A. Casing Liner: Flexible elastomeric duct liner fabricated of preformed, cellular, closed-cell, sheet materials complying with ASTM C534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.

1. Minimum Thickness: 3/4 inch.
2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

a. Adhesive shall have a VOC content of 80 g/L or less.

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Test assembled air terminal units according to AHRI 880.

1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, [coil type,]and AHRI certification seal.

PART 3 EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 5, "Hangers and Supports" and with Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hangers Exposed to View: Threaded rod and angle or channel supports.

D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.2 TERMINAL UNIT INSTALLATION

A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

C. Install wall-mounted thermostats.

3.3 DUCTWORK CONNECTIONS

A. Comply with requirements in [Section 233113 "Metal Ducts"] [Section 233116 "Nonmetal Ducts"] for connecting ducts to air terminal units.

B. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories."

3.4 ELECTRICAL CONNECTIONS

A. Install field power to each air terminal unit electrical power connection. Coordinate with air terminal unit manufacturer and installers.

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

E. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.6 IDENTIFICATION

A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.7 FIELD QUALITY CONTROL

A. Perform the following tests and inspections[with the assistance of a factory-authorized service representative]:

1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Air terminal unit will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.8 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
3. Verify that controls and control enclosure are accessible.
4. Verify that control connections are complete.
5. Verify that nameplate and identification tag are visible.
6. Verify that controls respond to inputs as specified.
7. .

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 233600

SECTION 233713.13 - AIR DIFFUSERS

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:

1. Rectangular and square ceiling diffusers.
2. Linear bar diffusers.
3. Linear slot diffusers.
4. Ceiling-integral continuous slot diffusers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 PRODUCTS

2.1 RECTANGULAR AND SQUARE CEILING DIFFUSERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Titus

2. Price

B. Devices shall be specifically designed for variable-air-volume flows.

C. Material: Steel.

D. Finish: Baked enamel, color selected by Architect.

2.2 LINEAR BAR DIFFUSERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Titus

2. Price

B. Devices shall be specifically designed for variable-air-volume flows.

C. Material: Steel.

D. Finish: Baked enamel, color selected by Architect.

E. Two-Way Deflection Vanes: Extruded construction louvers with removable core.

F. Accessories: Directional vanes Blank-off strips.

2.3 LINEAR SLOT DIFFUSERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Titus

2. Price

B. Devices shall be specifically designed for variable-air-volume flows.

C. Material - Shell: Steel, insulated.

D. Finish - Face and Shell: Insert finish.

E. Finish - Pattern Controller: Baked enamel, black.

2.4 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install diffusers level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713.13

SECTION 237219 - FIXED PLATE AIR-TO-AIR ENERGY RECOVERY UNITS

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:

1. Fixed-plate total heat exchangers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: For air-to-air energy recovery equipment.

1. Include plans, elevations, sections, and [mounting] [attachment] details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, elevations, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Mechanical-room layout and relationships between components and adjacent structural and mechanical elements.
2. Support location, type, and weight.
3. Field measurements.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-to-air energy recovery equipment to include in maintenance manuals.

1.6 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in a clean, dry place.

B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.

C. Handle products carefully to prevent damage, breakage, denting, and scoring. Do not install damaged products.

D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.

1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.
2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remover coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.
3. Replace installed products damaged during construction.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. 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.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.

C. ASHRAE Compliance:

1. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
2. Capacity ratings for air-to-air energy recovery equipment shall comply with ASHRAE 84, "Method of Testing Air-to-Air Heat/Energy Exchangers."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Comply with ASTM E84 or UL 723.

1. Insert requirements for Component Amplification Factor and Component Response Modification Factor.

2.2 FIXED-PLATE TOTAL HEAT EXCHANGERS

A. Casing: Galvanized steel.

B. Drain Pan: Same material as casing, with drain connections on exhaust and supply side .

1. Comply with requirements in ASHRAE 62.1.

C. Plates: Evenly spaced, sealed, and arranged for counter airflow.

D. Bypass Plenum: Within casing, with gasketed face-and-bypass dampers having operating rods extended outside casing.

E. Maximum Differential Pressure: Suitable for maximum 6-inch wg.

F. Maximum Temperature: Suitable for maximum 194 deg F.

2.3 SOURCE QUALITY CONTROL

A. AHRI 1060 Certification: Certified according to AHRI 1060.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical services to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fixed-plate heat exchangers so supply and exhaust airstreams flow in opposite directions.

1. Install duct access doors in both supply and exhaust ducts, both upstream and downstream, for access to heat exchanger. Access doors and panels are specified in Section 233300 "Air Duct Accessories."

B. Install floor-mounted units on 4-inch- high, concrete base[designed to withstand, without damage to equipment, seismic force required by code].

C. Equipment Mounting:

1. Install air-to-air energy recovery equipment on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

D. Install seismic restraints according to manufacturers' written instructions.

E. Install units with clearances for service and maintenance.

F. Comply with requirements for ductwork specified in Section 233113 "Metal Ducts."

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260529 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 250526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper water wash control and unit operation.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

E. Air-to-air energy recovery equipment will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to electrical systems are complete. Verify that proper thermal-overload protection is installed.
4. Verify water wash mechanism operation.

B. Starting procedures for air-handling units include the following:

1. Energize water wash motor and verify proper operation of motor and water wash system.
2. Measure and record motor electrical values for voltage and amperage.

3.7 ADJUSTING

A. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.8 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-to-air heat recovery unit,[and after completing startup service,] clean unit to remove foreign material and construction dirt and dust.

END OF SECTION 237219

SECTION 237313.19 - INDOOR, CUSTOM AIR-HANDLING UNITS

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 indoor, custom air-handling units with capacities, characteristics, and configurations indicated on Drawings.

1.3 ACTION SUBMITTALS

A. Product Data: For each air-handling unit.

1. Product information organized to show compliance with each performance requirement of "Performance Requirements" Article.
2. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
3. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
4. Include unit dimensions and weight.
5. Include cabinet material, metal thickness, finishes, insulation, and accessories.
6. Fans:

    a. Include certified fan-performance curves with system operating conditions indicated. For fans operating at variable speeds include curves in [10] <Insert number> percent speed increments starting at design speed down to minimum speed.
    b. Include fan-sound power ratings in all eight octave bands. Include inlet or outlet sound power levels to coincide with sound requirements indicated on Drawings.
    c. Include fan construction and accessories. Submit sufficient information to show product compliance with requirements indicated.
    d. Include dimensions and weight.
    e. Include motor ratings, electrical characteristics, and motor accessories.

7. Vibration isolation product data with performance ratings. Uniquely identify and include information for each different isolator type and indicate for each air-handling unit where each isolator type is being used.
8. Include certified coil-performance ratings with system operating conditions indicated. Product data to include dimensions, dry and operating weight, volume of fluid contained, materials of construction, and performance ratings with system operating conditions indicated.
9. Casing insulation product data and performance ratings.
10. Access door and access panel product data and performance ratings.
11. Paint product data and performance ratings.

12. Electrical product data and performance ratings.
13. Metal grating product data and performance ratings.
14. Electric heater product data with performance ratings.
15. Steam humidifier product data with performance ratings.
16. Dampers product data, including housings, linkages, and operators with performance ratings.
17. Filters product data with performance characteristics.
18. Heat wheels product data with performance ratings.
19. Fixed plate heat exchangers product data with performance ratings.
20. Heat pipe heat exchangers product data with performance ratings.
21. Duct silencers product data with performance ratings.
22. Air blender product data with dimensions, weights, materials of construction, performance ratings, and installation requirements.
23. UV-C lamp systems product data with performance ratings.
24. <Insert requirements>.

B. Shop Drawings: For each type and configuration of indoor, custom air-handling unit.

1. Prepared by manufacturer's factory employees with review and sign-off by those individuals responsible for manufacturing the air-handling units.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, sections, and other details, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.

B. Startup service reports.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.6 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

1.7 DELIVERY, STORAGE, HANDLING

A. Deliver air-handling units with factory-installed shipping skids and lifting lugs; pack small components in factory-fabricated protective containers. Cover units with heat-shrinkable plastic sheeting suitable for shipping from point of manufacture to Project.

B. Handle air-handling units carefully to avoid damage to components, casing, and finish. Do not install damaged components; replace and return damaged components to air-handling unit manufacturer.

C. Store air-handling units in a clean dry place and protect them from weather and construction activities.

D. Keep air-handling units fully covered and protected during construction. Remove dirt and debris and clean units to a factory-cleaned condition.

E. Comply with manufacturer's written rigging and installation instructions for unloading air-handling units and moving them to their final locations.

F. For air-handling units equipped with key locks on access doors, keep doors locked during construction.

1. If access is required within air-handling units, only open the doors to sections that require access and lock doors at the end of each [workday] [work shift] <Insert requirement>.
2. Protect inside of air-handling units from damage and keep inside of units as clean as the factory-cleaned condition.
3. Report observed abuse to <Insert entity> for immediate corrective action.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handing units and components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Delegated Design: Engage a qualified professional [specialist] [engineer], as defined in Section 014000 "Quality Requirements," to design air-handling units, [vibration isolation,] [and seismic restraints] including comprehensive engineering analysis, using performance requirements and design criteria indicated.

F. Casing Structural Performance:

1. Floor: Capable of withstanding positive/negative 8 inches wg of internal static pressure, without exceeding a deflection of [L/300] [L/360] <Insert deflection> of span.
2. Walls and Roof: Capable of withstanding positive/negative 8 inches wg of internal static pressure, without exceeding a midpoint deflection of [L/200] [L/240] <Insert deflection> of span.

G. Casing Leakage Performance, ASHRAE 111: Class 3 leakage or better at plus or minus 8 inches wg.

H. Casing Leakage Performance: Comply with more stringent of the following requirements:

1. ASHRAE 111, Class 3 leakage or better at plus or minus 8 inches wg.
2. Not more than 0.5 percent of the total unit airflow at 8 inches wg.

I. Casing Thermal Performance:

1. Surface Condensation: Air-handling manufacturer shall evaluate potential for condensation and design and manufacture entire unit casing to prevent condensation at most extreme operating conditions encountered.
2. Thermal Break: Incorporate a thermal break at each through metal path to prevent condensation from occurring on interior and exterior of casing.
3. U-Value: Overall U-value or equivalent R-value of casing shall not exceed governing codes and ASHRAE/IES 90.1, while considering the effects of metal-to-metal contact and thermal bridging in calculations.

J. Air Tunnel Aerodynamic Performance: Position air-handling unit internal components and transition between internal components to maintain uniform airflow; minimize sound levels and energy consumption. Use methods indicated and other means to ensure compliance.

1. Use turning vanes if necessary to direct the air path.

    a. Design, manufacture, and install vanes in accordance with applicable requirements in ASHRAE and SMACNA guidelines, handbooks, and standards.
    b. Install vanes firmly in place so that no vane movement occurs at worst-case airflow capacity possible.

2. Use fan inlet and discharge transitions and other devices to maximize system regain and minimize airborne sound levels.
3. Center system components such as coils, fans, and filters, vertically and horizontally, in airstream.
4. Maintain spacing between components such that airflow patterns to adjacent components are as uniform as possible and that component "dead spots" or "jetted areas" are avoided.
5. Design and install internal structural supports, piping, and conduit that do not block airflow and impede performance of coils, fans, filters, and other unit components, and service space clearances.

K. Air-Handling Unit Acoustical Performance:

1. Radiated Noise: Noise radiated from air-handling unit casing[and openings not ducted] shall not exceed following sound pressure levels when measured [3 feet] <Insert distance> away from any exterior surface of unit. Sound pressure levels indicated in each octave band are in decibels (dB) (reference 20 µPa).

    a. 63 Hz: <Insert value> dB.
    b. 125 Hz: <Insert value> dB.
    c. 250 Hz: <Insert value> dB.
    d. 500 Hz: <Insert value> dB.
    e. 1000 Hz: <Insert value> dB.

f. 2000 Hz: <Insert value> dB.
g. 4000 Hz: <Insert value> dB.

L. Casing Acoustical Performance:

1. Sound Absorption: Minimum acceptable sound absorption coefficient and noise reduction coefficient (NRC) of perforated inside casing assemblies when tested by an independent testing laboratory in accordance with ASTM C423 and ASTM E795.

a. 125 Hz: <Insert value> dB.
b. 250 Hz: <Insert value> dB.
c. 500 Hz: <Insert value> dB.
d. 1000 Hz: <Insert value> dB.
e. 2000 Hz: <Insert value> dB.
f. 4000 Hz: <Insert value> dB.
g. NRC: <Insert value>.

2. Sound Transmission: Minimum acceptable sound transmission loss and STC of proposed cabinet construction when tested by an independent testing laboratory in accordance with ASTM E90 and ASTM E413.

a. 125 Hz: <Insert value> dB.
b. 250 Hz: <Insert value> dB.
c. 500 Hz: <Insert value> dB.
d. 1000 Hz: <Insert value> dB.
e. 2000 Hz: <Insert value> dB.
f. 4000 Hz: <Insert value> dB.
g. STC: <Insert value>.

M. Durability Performance: Design and manufacture air-handling units with underlying requirement to provide a highly durable piece of equipment.

1. Unit Life Expectancy: [25] <Insert number> years.
2. Supporting Documentation: Submit documentation showing proposed products to consider and include design features, components, and materials to satisfy requirement.

N. Extreme Operating Conditions:

1. Corrosive Environments: Air-handling unit manufacturer shall evaluate the quality and potential corrosiveness of air passing through air-handling units and propose additional protective finishes and better-quality materials of a heavier thickness if required to comply with requirements indicated.

a. Unless otherwise indicated, air-handling units for HVAC applications may use up to 100 percent of outdoor air or a mix of outdoor air with return air from habitable areas served.[Projects located in coastal and industrial areas may require added protection.]
b. Air-handling units circulating [Class 3] [and] [Class 4] exhaust air in accordance with ASHRAE 62.1 could potentially be hot, humid, and corrosive and may require added protection.

2. Humidity and Temperatures: Materials and components of air-handling units shall be suitable for use in low and high humidity and temperature extremes when operating under normal and abnormal conditions without permanent degradation or loss in material performance.

O. Safety:

1. Comply with OSHA regulations.
2. Exposed sharp edges and corners of metal shall be protected or rounded to prevent injury to personnel not wearing gloves.
3. Cover exposed ends of screws with plastic or metal covers to prevent injury to personnel coming in contact with screws.

P. Serviceability:

1. Hoisting Provisions: Fans and motors weighing more than [200 lb] <Insert weight> to have full-length hoist rails mounted over the equipment to facilitate service, removal, and replacement.
2. Mounting Location: Install internal components in readily accessible locations to facilitate ease of service and replacement.
3. Service Access:

    a. Internal components shall be serviceable through access sections with doors indicated on Drawings.
    b. Internal components shall be removable and replaceable through access doors or panels.
    c. Review requirements for access doors and panels indicated and recommend additional access doors and panels if required for uninhabited service, removal, and replacement of components.

4. Tripping Hazards: Floors in accessible sections of air-handling unit shall be free of standing seams, reinforcing, supports, or section splits located in the walking path that is capable of causing a tripping hazard. Locate section splits immediately adjacent to internal walls.

Q. Quality: Type and thickness of materials indicated are the minimum acceptable. Provide better-quality materials of a heavier thickness if required to comply with performance requirements indicated.

1. If manufacturer's standard construction exceeds requirements indicated, use manufacturer's standard construction.
2. If manufacturer's standard construction does not comply with requirements indicated, modify manufacturer's standard construction to comply with requirements.

R. Seismic Performance: Air-handling units shall withstand the effects of earthquake motions determined in accordance with [ASCE/SEI 7] <Insert requirement>.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[and the unit will be fully operational after the seismic event]."
2. Component Importance Factor: [1.5] [1.0].
3. <Insert requirements for Component Amplification Factor and Component Response Modification Factor>.

S. Vibration Performance: Air-handling unit manufacturer shall evaluate vibration of internal components installed inside of air-handling units and include internal vibration isolation required to limit the vibration transmitted to the building at a low enough level that vibration is not perceived by building occupants.

2.2 CAPACITIES AND CHARACTERISTICS

A. See equipment schedules on Drawings.

2.3 SOURCE LIMITATIONS

A. Source all indoor [and outdoor]custom air-handling units from same manufacturer.

B. Like components furnished with air-handling units shall be from same manufacturer.

C. Air-handling units shall be manufactured in [United States] [United States or Canada] [North America] <Insert requirement>.

D. <Insert requirements>.

2.4 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

1. Haakon Industries.
2. Trane; An Ingersoll Rand Company.
3. VenMar

EXECUTION

2.5 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine air-handling units before installation. Reject units with physical damage, and air-handling unit components that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for the following before installation of air-handling units:

1. Structural substrate mounting and anchorage to verify actual sizes, types, and locations.
2. Piping systems to verify actual sizes, types, and locations of connections.
3. Ductwork and plenums to verify actual sizes, types, and locations of connections.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

2.6 PROTECTION DURING CONSTRUCTION

A. Exterior Covers: Cover air-handling units during construction with sealed covers to protect air-handling unit casing and externally mounted components from physical damage, dirt, dust and debris, paint splatter, and any other construction materials.

1. Minor physical damage, as determined by Owner, shall be repaired by air-handling unit factory service personnel to factory-finished condition.
2. Replace air-handling units with damage that in any way compromises the performance indicated.

2.7 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to air-handling unit, provide unobstructed access to inside of air-handling units for service and maintenance.

C. Connect piping to air-handling units with flexible connectors.

D. Air-Handling Unit Floor Drains: Do not require installation of permanent drain piping.

E. Air-Handling Unit Floor Drain Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping."

1. Make connections to air-handling unit connections with [flanges or]unions.
2. Extend [dedicated]drain piping from each air-handling unit connection to nearest equipment or floor drain and arrange piping to maintain clear service aisle paths free of potential tripping hazards.
3. Construct traps near air-handling unit connections to seal airflow from escaping within air-handling unit. Locate traps in a serviceable location that is away from access doors.
4. Install threaded cleanouts at changes in direction.
5. Secure drain piping to structure.

F. Chilled-[and Hot-]Water Coil Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."

1. Comply with requirements indicated on Drawings.
2. Make connections to coils with a [flange] [or] [union].
3. Connect to each coil inlet with shutoff valve, test plug, [pressure gauge] [and] [thermometer].
4. Connect to each coil outlet with balancing valve, test plug, [pressure gauge] [thermometer] [flow meter] [and] [shutoff valve].
5. Connect each coil drain connection with a drain valve, which is full size of drain connection.[Connect drain pipe to drain valve with union, and extend drain pipe to terminate over floor drain.]
6. Connect each coil vent connection with [automatic] [or] [manual] vent, which is full size of vent connection.

G. Refrigerant Coil Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." Install shutoff valve at each supply and return connection.

2.8 STARTUP SERVICE

A. Engage an air-handling unit factory[-authorized] service representative to perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, controls, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that face-and-bypass dampers provide full face flow.
7. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
8. Comb coil fins for parallel orientation.
9. Verify that proper thermal-overload protection is installed for electric heaters.
10. Install new, clean filters.
11. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.
12. <Insert requirement>.

B. Starting procedures for air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.[Replace fan and motor pulleys as required to achieve design conditions.]
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.
4. <Insert requirement>.

C. Heat Wheel Startup Service:

1. After field installation is complete, a final checkout and startup shall be completed to ensure proper purge adjustment, seal adjustment, control settings, and other key operational functions.
2. Service shall be completed by trained factory service personnel employed by heat wheel manufacturer.
3. Submit a report summarizing findings, adjustments made, and final settings.

2.9 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

C. Before turning equipment over to Owner for use, adjust air-handling unit components that require further adjustment for proper operation. Consult air-handling unit manufacturer for instruction.

D. Occupancy Adjustments: When requested within [12] <Insert number> months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to visits to Project during other-than-normal occupancy hours for this purpose.

E. Seasonal Adjustments: Make seasonal visits during warranty period to inspect and review operation of equipment. Make necessary adjustments for components observed to require adjustments for proper operation. Prepare and submit a report to Owner documenting each visit, observations, and any adjustments made.

2.10 CLEANING

A. Cleaning Schedule: After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems, and after completing startup service, and immediately before Owner use, clean air-handling units to remove foreign material and construction dirt and dust.

B. Unit Interior: Clean air-handling units internally to factory clean condition. Remove foreign material and construction debris, dirt, and dust.

1. Vacuum clean with HEPA-filtered vacuum and then wipe down with cleaning solution.
2. Clean casing floors, roofs, wall surfaces, access doors, and panels.
3. Clean all internal components, such as, coils, dampers, filter frames, fans, and motors.
4. Clean light fixtures and control devices.

C. Unit Exterior: Clean external surfaces of air-handling units to factory clean condition. Remove foreign material and construction debris, dirt, and dust. Vacuum clean with HEPA-filtered vacuum and then wipe down all surfaces with cleaning solution.

D. Cleaning Materials: Use cleaning materials and products recommended in writing by air-handling unit manufacturer.

E. Acceptance: Following unit cleaning, submit a written request for review and [Owner]acceptance. Acceptance for cleaning of air-handling units [with absolute filters]must pass a white glove test.

2.11 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections[with the assistance of a factory-authorized service representative].

1. After field piping connections are complete, test [hydronic] [and] [steam] coils and connections for leaks.
2. Charge refrigerant coils with refrigerant and test for leaks.
3. Field-Assembly Supervision: Instruct Installer and supervise field installation of [first] <Insert quantity> air-handling unit(s) shipped in multiple pieces for field assembly.
4. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Field Casing Leakage Test:

1. Perform leak testing of air-handling units that include field assembly of multiple sections. Air-handling units that are shipped and installed as a single piece do not require field testing.
2. Leak test [one] <Insert value> air-handling unit(s) of each unique size and arrangement randomly selected by [Architect] [Commissioning Agent] [Owner].
3. Follow procedures complying with ASHRAE 111.
4. Assembled air-handling units shall satisfy leakage criteria indicated. Modify air-handling units that fail to satisfy criteria and retest. For every air-handling unit that fails test, another air-handling unit shall be tested until all air-handling units tested pass leakage criteria on first attempt.
5. Submit a test report for each test indicating test equipment, procedures, results, date and time, and full name of personnel performing tests and witnesses.
6. Test report shall be in accordance with ASHRAE 111.
7. Witness Testing:

    a. Provide written notification at least [30] [20] <Insert number> business days in advance of testing.
    b. Testing shall be conducted in presence of testing and balancing agent.
    c. Other parties such as Architect, Commissioning Agent, and Owner shall be invited to witness testing with attendance being optional.

E. Field Fan Vibration Test:

1. Perform fan vibration testing for every one out of [10] <Insert number> air-handling unit fans randomly selected by [Architect] [Commissioning Agent] [Owner].
2. Test after air-handling unit installation is complete.
3. Three vibration readings shall be taken for each bearing in horizontal, vertical, and axial directions. Record each reading including vibration amplitude verses frequency.
4. Modify fans that fail to satisfy performance criteria and retest. For every fan that fails test, another fan shall be tested until all fans tested pass criteria on first attempt.
5. Submit a report for each fan tested indicating air-handling unit designation, fan designation, test equipment, procedures, results, date and time, and full name of personnel performing tests and witnesses.
6. Witness Testing:

    a. Provide written notification at least [30] [20] <Insert number> business days in advance of testing.
    b. Testing shall be conducted in presence of testing and balancing agent.

c. Other parties such as Commissioning Agent, Architect, and Owner shall be invited to witness testing with attendance being optional.

F. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

G. Prepare test and inspection reports.

2.12 OPERATION DURING CONSTRUCTION

A. Operation of air-handling units for temporary cooling, heating, and ventilation is not allowed without Owner authorization.

1. Submit written request for Owner approval by signature with detailed description of operating procedures to be followed including, but not limited to, the following:

a. Operation:

1) Beginning and ending calendar dates.
2) List each day during week.
3) List start and stop time and hours for each day.

b. Startup procedures and shut-down procedures.
c. Provisions for routine monitoring of unit operation.
d. Provisions to prevent and protect against damage to equipment due to adverse operation such as, low temperature, high temperature, over pressure, fire, smoke, electrical over- and undervoltage, and current and electrical fault.
e. Provisions and safeguards for filtration to keep inside of units from getting dirty.
f. Record keeping.

2. If approved by Owner, units used for temporary cooling, heating, and ventilation during and before interior finish work is complete shall include an unconditional complete unit labor and parts warranty to extend at least years after the warranty indicated expires.
3. Interior and exterior of air-handling units shall be cleaned to a factory-cleaned condition and clean condition must be accepted by Owner.

B. Filtration during Temporary Use:

1. Protect air-handling system ducts (exhaust air, outdoor air, and return air) with temporary filters installed and supported to prevent filter media from collapse and bypass of unfiltered air. Temporary media shall be installed at each inlet and shall have a published filtration efficiency of MERV [8] [11] [13] <Insert MERV> in accordance with ASHRAE 52.2.
2. Protect air-handling units with open inlets that are not ducted with temporary filters installed and supported to prevent filter media from collapse and bypass of unfiltered air. Temporary media shall be installed at each inlet and shall have a published filtration efficiency of MERV [8] [11] [13] <Insert MERV> in accordance with ASHRAE 52.2.
3. Do not operate air-handling units until both temporary and scheduled permanent air-handling unit particulate filters are in place. Temporary filters must be installed upstream of permanent filters while units are operating.
4. Replace temporary and permanent filters used during construction when dirty. After end of temporary use, replace permanent filters with new, clean filters before beginning testing, adjusting, and balancing.

C. Comply with SMACNA 008, "IAQ Guidelines for Occupied Buildings under Construction," for procedures to protect HVAC system.

2.13 DEMONSTRATION

A. Engage air-handling unit manufacturer [employed training instructor] [or] [factory-authorized service representative] to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

B. Training shall include, but not be limited to, procedures and schedules related to performance, safety, startup and shut down, troubleshooting, servicing, preventive maintenance, and how to obtain replacement parts.

1. Damper Assemblies: Cleaning, operation, service, removal and replacement, and spare parts.
2. Fan and Motor Assemblies: Cleaning, operation, removal and replacement, service, and spare parts.
3. Humidifiers: Cleaning, operation, service, removal and replacement, and spare parts.
4. UV-C Lamp Systems: Cleaning, operation, service, removal and replacement, and spare parts.
5. Lights, Receptacles, and Switches: Cleaning, operation, service, removal and replacement, and spare parts.
6. <Insert requirement>.

C. Instructor:

1. Instructor shall be factory trained and certified by air-handling unit manufacturer with current training on equipment installed.
2. Instructor's credentials shall be submitted for review by [Architect] [Commissioning Agent] [Owner] before scheduling training.
3. Instructor(s) [primary] [sole] job responsibility shall be Owner training.
4. Instructor(s) shall have not less than [three] <Insert number> years of training experience with air-handling unit manufacturer and past training experience on at least [three] <Insert number> projects of comparable size and complexity.

D. Schedule and Duration:

1. Schedule training with Owner at least [20] <Insert number> business days before first training session.
2. Training shall occur before Owner occupancy.
3. Training shall be held at mutually agreed date and time during normal business hours.
4. Each training day shall not exceed [eight] <Insert number> hours of training. Daily training schedule shall allow time for a [one] <Insert number>-hour lunch period and [15] <Insert number>-minute break after every [two] <Insert number> hours of training.
5. Perform not less than [eight] [16] [24] <Insert number> hours of training.

E. Training Attendees: Assume [three] <Insert number> people.

F. Training Attendance Records: For record purposes, document training attendees at start of each new training session. Record date, time, brief description of training covered during the session, attendee's name, signature, phone number, and e-mail address. Submit scanned copy of sign-in sheet to Owner for each training session.

G. Training Format: Individual training modules toinclude classroom training followed by hands-on field demonstration and training.

H. Training Materials: Provide training materials in electronic format to each attendee.

1. Include instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.

I. Training Video Recording: Video record each classroom training session and submit an electronic copy to Owner before requesting Owner acceptance of training.

J. Written Acceptance: Obtain [Architect] [Commissioning Agent] [or] [Owner] written acceptance that training is complete and requirements indicated have been satisfied.

END OF SECTION 237313.19

SECTION 238129 - VARIABLE REFRIGERANT FLOW HVAC SYSTEMS

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 complete VRF HVAC system(s) including, but not limited to, delegated design and the following components to make a complete operating system(s) according to requirements indicated:

1. Indoor, concealed, ceiling-mounted units for ducting.
2. Indoor, exposed, wall-mounted units.
3. Indoor, hydronic heat recovery units.
4. Outdoor, air-source, heat-pump units.
5. Heat recovery control units.
6. System refrigerant and oil.
7. System condensate drain piping.
8. Miscellaneous support materials.
9. Piping and tubing insulation.
10. System control cable and raceways.

1.3 DEFINITIONS

A. Air-Conditioning System Operation: System capable of operation with all zones in cooling only.

B. Heat-Pump System Operation: System capable of operation with all zones in either heating or cooling, but not with simultaneous heating and cooling zones that transfer heat between zones.

C. Heat Recovery System Operation: System capable of operation with simultaneous heating and cooling zones that transfer heat between zones.

D. HRCU: Heat Recovery Control Unit. HRCUs are used in heat recovery VRF HVAC systems to manage and control refrigerant between indoor units to provide simultaneous heating and cooling zones. "Heat Recovery Control Unit" is the term used by ASHRAE for what different manufacturers term as branch circuit controller, branch selector box, changeover box, flow selector unit, mode change unit, and other such terms.

E. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

F. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.

G. Three-Pipe System Design: One high pressure refrigerant vapor line, one low pressure refrigerant vapor line, and one refrigerant liquid line connect a single outdoor unit or multiple manifold outdoor units in a single system to associated system HRCUs. One liquid line and refrigerant vapor line connect HRCUs to associated indoor units.

H. Two-Pipe System Design: One refrigerant vapor line and one refrigerant liquid line connect a single outdoor unit or multiple manifold outdoor units in a single system to associated system HRCUs. One refrigerant liquid line and refrigerant vapor line connect HRCUs to associated indoor units. HRCUs used in two pipe systems act as an intermediate heat exchanger and include diverting valves and gas/liquid separators to move high and low pressure refrigerant between indoor units.

I. VRF: Variable refrigerant flow.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for indoor and outdoor units and for HRCUs.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Include operating performance at design conditions and at extreme maximum and minimum outdoor ambient conditions.
4. Include description of system controllers, dimensions, features, control interfaces and connections, power requirements, and connections.
5. Include system operating sequence of operation in narrative form for each unique indoor- and outdoor-unit and HRCU control.
6. Include description of control software features.
7. Include total refrigerant required and a comprehensive breakdown of refrigerant required by each system installed.
8. Include refrigerant type and data sheets showing compliance with requirements indicated.
9. For system design software.
10. Indicate location and type of service access.

B. Shop Drawings: For VRF HVAC systems.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
4. Include diagrams and details of refrigerant piping and tubing showing installation requirements for manufacturer-furnished divided flow fittings.
5. Include diagrams for power, signal, and control wiring.

1.5 QUALITY ASSURANCE

A. Mockups: Build mockups to set quality standards for materials and execution.

1. Build mockups to show a finished installation for each of the following applications:

a. Horizontal Fan Coil Unit. Full mockup shall include:

1) 5 ft of connected supply ductwork
2) Return Plenum
3) 5 feet of connected refrigerant piping
4) 5 feet of connected condensate drain
5) Outside air volume flow controller
6) Modulating outside air damper
7) Vibration isolation
8) All accessories required by manufacturer's install guidelines

2. Mockups shall be operational.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in a clean and dry place.

B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.

C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.

D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.

1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.
2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remover coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.

E. Replace installed products damaged during construction.

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace equipment and components that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures.
b. Faulty operation.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period:

a. For Compressor: Five year(s) from date of Substantial Completion.
b. For Parts, Including Controls: Five year(s) from date of Substantial Completion.
c. For Labor: Five year(s) from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Mitsubishi

2. Samsung
3. Daikin

B. Source Limitations: Obtain products from single source from single manufacturer including, but not limited to, the following:

1. Indoor and outdoor units, including accessories.
2. Controls and software.
3. HRCUs.
4. Refrigerant isolation valves.
5. Specialty refrigerant pipe fittings.

2.2 SYSTEM DESCRIPTION

A. Direct-expansion (DX) VRF HVAC system(s) with variable capacity in response to varying cooling and heating loads. System shall consist of multiple indoor units, HRCUs, outdoor unit(s), piping, controls, and electrical power to make complete operating system(s) complying with requirements indicated.

1. Two-pipe or three-pipe system design.
2. System(s) operation, heat recovery as indicated on Drawings.
3. Each system with one refrigerant circuit shared by all indoor units connected to system.

B. 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.

C. AHRI Compliance: System and equipment performance certified according to AHRI 1230 and products listed in AHRI directory.

D. ASHRAE Compliance:

1. ASHRAE 15: For safety code for mechanical refrigeration.
2. ASHRAE 62.1: For indoor air quality.
3. ASHRAE 135: For control network protocol with remote communication.
4. ASHRAE/IES 90.1 Compliance: For system and component energy efficiency.

E. UL Compliance: Comply with UL 1995.

2.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional specialist, as defined in Section 014000 "Quality Requirements," to design complete and operational VRF HVAC system(s) complying with requirements indicated.

1. Provide system refrigerant calculations.

    a. Refrigerant concentration limits shall be within allowable limits of ASHRAE 15 and governing codes.
    b. Indicate compliance with manufacturer's maximum vertical and horizontal travel distances. Prepare a comparison table for each system showing calculated distances compared to manufacturer's maximum allowed distances.

2. Include a mechanical ventilation system and gas detection system as required to comply with ASHRAE 15 and governing codes.
3. System Refrigerant Piping and Tubing:

    a. Arrangement: Arrange piping to interconnect indoor units, HRCUs, and outdoor unit(s) in compliance with manufacturer requirements and requirements indicated.
    b. Routing: Conceal piping above ceilings and behind walls to maximum extent possible.
    c. Sizing: Size piping system, using a software program acceptable to manufacturer, to provide performance requirements indicated. Consider requirements to accommodate future change requirements.

4. System Controls:

    a. Network arrangement.
    b. Network interface with other building systems.
    c. Product selection.
    d. Sizing.

B. Service Access:

1. Provide and document service access requirements.
2. Locate equipment, system isolation valves, and other system components that require service and inspection in easily accessible locations. Avoid locations that are difficult to access if possible.
3. Where serviceable components are installed behind walls and above inaccessible ceilings, provide finished assembly with access doors or panels to gain access. Properly size the openings to allow for service, removal, and replacement.
4. If less than full and unrestricted access is provided, locate components within an 18-inch reach of the finished assembly.

5. Where ladder access is required to service elevated components, provide an installation that provides for sufficient access within ladder manufacturer's written instructions for use.
6. Comply with OSHA regulations.

C. System Design and Installation Requirements:

1. Design and install systems indicated according to manufacturer's recommendations and written instructions.
2. Where manufacturer's requirements differ from requirements indicated, contact Architect for direction. The most stringent requirements should apply unless otherwise directed in writing by Architect.

D. System Adaptability to Future Changes: Arrange and size system refrigerant piping to accommodate future changes to system without having to resize and replace existing refrigerant piping.

1. Future changes to system(s) indicated on Drawings.
2. Each branch circuit shall accommodate addition of two indoor unit(s) with unit capacity equal to average indoor unit connected to the branch circuit.
3. Each branch circuit shall accommodate deletion of two indoor unit(s) with unit capacity equal to average indoor unit connected to the branch circuit.

E. Isolation of Equipment: Provide isolation valves to isolate each HRCU, indoor unit and outdoor unit for service, removal, and replacement without interrupting system operation.

F. System Capacity Ratio: The sum of connected capacity of all indoor units shall be within the following range of outdoor-unit rated capacity:

1. Range acceptable to manufacturer.

G. System Turndown: Stable operation down to 20 percent of outdoor-unit capacity.

H. Sound Performance: Sound levels generated by operating HVAC equipment shall be within requirements indicated.

1. Indoor: Within design guidelines of "2015 ASHRAE HANDBOOK- HVAC Applications."

I. Thermal Movements: Allow for controlled thermal movements from ambient, surface, and system temperature changes.

J. Capacities and Characteristics: As indicated on Drawings.

2.4 INDOOR, CONCEALED, CEILING-MOUNTED UNITS FOR DUCTING

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.

B. Cabinet:

1. Material: Galvanized steel.
2. Insulation: Manufacturer's standard internal insulation, complying with ASHRAE 62.1, to provide thermal resistance and prevent condensation.

3. Duct Connections: Extended collar or flange, or designated exterior cabinet surface, designed for attaching field-installed ductwork.
4. Mounting: Manufacturer-designed provisions for field installation.
5. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. DX Coil Assembly:

1. Coil Casing: Aluminum, galvanized, or stainless steel.
2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
3. Coil Tubes: Copper, of diameter and thickness required by performance.
4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
5. Unit Internal Tubing: Copper tubing with brazed joints.
6. Unit Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
7. Field Piping Connections: Manufacturer's standard.
8. Factory Charge: Dehydrated air or nitrogen.
9. Testing: Factory pressure tested and verified to be without leaks.

D. Drain Assembly:

1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
2. Condensate Removal: Unit-mounted pump or other integral lifting mechanism, capable of lifting drain water to an elevation above top of cabinet.
3. Field Piping Connection: Non-ferrous material with threaded NPT.

E. Fan and Motor Assembly:

1. Fan(s):

    a. Direct-drive arrangement.
    b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
    c. Fabricated from non-ferrous components or ferrous components with corrosion-resistant finish.
    d. Wheels statically and dynamically balanced.

2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
5. Vibration Control: Integral isolation to dampen vibration transmission.

F. Filter Assembly:

1. Access: Bottom, side, or rear to accommodate field installation without removing ductwork and to accommodate filter replacement without need for tools.
2. Efficiency: ASHRAE 52.2, MERV 13.
3. Media:

    a. Replaceable: Extended surface, panel, or cartridge with antimicrobial treatment fiber media.

G. Unit Controls:

1. Enclosure: Metal, suitable for indoor locations.
2. Factory-Installed Controller: Configurable digital control.
3. Factory-Installed Sensors:

    a. Unit inlet air temperature.
    b. Coil entering refrigerant temperature.
    c. Coil leaving refrigerant temperature.

4. Communication: Network communication with other indoor and outdoor units.
5. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

H. Unit Electrical:

1. Enclosure: Metal, suitable for indoor locations.
2. Field Connection: Single point connection to power unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in metal raceways.

2.5 INDOOR, EXPOSED, WALL-MOUNTED UNITS

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

B. Cabinet:

1. Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.
2. Insulation: Manufacturer's standard internal insulation, complying with ASHRAE 62.1, to provide thermal resistance and prevent condensation.
3. Mounting: Manufacturer-designed provisions for field installation.

C. DX Coil Assembly:

1. Coil Casing: Aluminum, galvanized, or stainless steel.
2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
3. Coil Tubes: Copper, of diameter and thickness required by performance.
4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
5. Unit Internal Tubing: Copper tubing with brazed joints.
6. Unit Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
7. Field Piping Connections: Manufacturer's standard.
8. Factory Charge: Dehydrated air or nitrogen.

9. Testing: Factory pressure tested and verified to be without leaks.

D. Drain Assembly:

1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
2. Condensate Removal: Gravity.

    a. If a floor drain is not available at unit, provide unit with field-installed condensate pump accessory.

3. Field Piping Connection: Non-ferrous material with threaded NPT.

E. Fan and Motor Assembly:

1. Fan(s):

    a. Direct-drive arrangement.
    b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
    c. Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
    d. Wheels statically and dynamically balanced.

2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
5. Vibration Control: Integral isolation to dampen vibration transmission.

F. Unit Accessories:

1. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.
2. Condensate Pump: Integral reservoir and control with electrical power connection through unit power.

G. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
2. Factory-Installed Controller: Configurable digital control.
3. Communication: Network communication with other indoor units and outdoor unit(s).
4. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
5. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

H. Unit Electrical:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.

5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in metal raceways to comply with NFPA 70.

2.6 AIR COOLED HEAT RECOVERY UNITS

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

1. Specially designed for use in systems with simultaneous heating and cooling.
2. Systems shall consist of one unit, or multiple unit modules that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.
3. All units installed shall be from the same product development generation.

B. Compressor and Motor Assembly:

1. One or more positive-displacement, direct-drive and hermetically sealed scroll compressor(s) with inverter drive and turndown to 15 percent of rated capacity.
2. Protection: Integral protection against the following:

    a. High and low refrigerant pressure.
    b. Low oil level.
    c. High oil temperature.
    d. Thermal and overload.
    e. Voltage fluctuations.
    f. Phase failure and phase reversal.
    g. Short cycling.

3. Speed Control: Variable to automatically maintain refrigerant suction and condensing pressures while varying refrigerant flow to satisfy system cooling and heating loads.
4. Vibration Control: Integral isolation to dampen vibration transmission.
5. Oil management system to ensure safe and proper lubrication over entire operating range.
6. Crankcase heaters with integral control to maintain safe operating temperature.
7. Fusible plug.

C. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.

D. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for unprotected outdoor locations.
2. Factory-Installed Controller: Configurable digital control.
3. Factory-Installed Sensors:

    a. Entering-air temperature.
    b. Leaving-air temperature.
    c. Refrigerant suction temperature.
    d. Refrigerant discharge temperature.
    e. Refrigerant high pressure.
    f. Refrigerant low pressure.
    g. Oil level.

4. Features and Functions: Self-diagnostics, time delay, auto-restart, fuse protection, not less than 15 steps of capacity control, freeze protection sensor, proof of water flowautomatic control through a remote signal.
5. Communication: Network communication with indoor units and other outdoor unit(s).
6. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
7. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

E. Unit Electrical:

1. Enclosure: Metal, similar to enclosure, and suitable for unprotected outdoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in metal raceways to comply with NFPA 70.

F. Unit Hardware: Zinc-plated steel, or stainless steel.

G. Unit Piping:

1. Unit Tubing: Copper tubing with brazed joints.
2. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
3. Field Piping Connections: Manufacturer's standard.
4. Factory Charge: Dehydrated air or nitrogen.
5. Testing: Factory pressure tested and verified to be without leaks.

2.7 HEAT RECOVERY CONTROL UNITS (HRCUs)

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

1. Specially designed for use in systems with simultaneous heating and cooling.
2. Systems shall consist of one unit, or multiple unit that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.

B. Cabinet:

1. Galvanized-steel construction.
2. Insulation: Manufacturer's standard internal insulation to provide thermal resistance and prevent condensation.
3. Mounting: Manufacturer-designed provisions for field installation.
4. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.

D. Refrigeration Assemblies and Specialties:

1. Specially designed by manufacturer for type of VRF HVAC system being installed, either two or three pipe.
2. Each refrigerant branch circuit shall have refrigerant control valve(s) to control refrigerant flow.
3. Spares: Each heat recovery control unit shall include at least two branch circuit port(s) for future use.
4. Each system piping connection upstream of heat recovery unit shall be fitted with an isolation valve to allow for service to any heat recovery control unit in the system without interrupting operation of the system.
5. Each branch circuit connection shall be fitted with an isolation valve and capped service port to allow for service to any individual branch circuit without interrupting operation of the system.

    a. If not available as an integral part of the heat recovery control unit, isolation valves shall be field installed adjacent to the unit pipe connection.

E. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
2. Factory-Installed Controller: Configurable digital control.
3. Factory-Installed Sensors: .
4. Communication: Network communication with indoor units and outdoor unit(s).
5. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

F. Unit Electrical:

1. Enclosure: Metal, similar to enclosure, and suitable for indoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in [metal]raceways to comply with NFPA 70.

G. Unit Piping:

1. Unit Tubing: Copper tubing with brazed joints.
2. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
3. Field Piping Connections: Manufacturer's standard.
4. Factory Charge: Dehydrated air or nitrogen.
5. Testing: Factory pressure tested and verified to be without leaks.

2.8 SYSTEM REFRIGERANT AND OIL

A. Refrigerant:

1. As required by VRF HVAC system manufacturer for system to comply with performance requirements indicated.
2. ASHRAE 34, Class A1 refrigerant classification.
3. R-410a.

B. Oil:

1. As required by VRF HVAC system manufacturer and to comply with performance requirements indicated.

2.9 SYSTEM CONDENSATE DRAIN PIPING

A. If more than one material is listed, material selection is Contractor's option.

B. Copper Tubing:

2.10 SYSTEM HYDRONIC PIPING

A. Comply with requirements in Section 232113 "Hydronic Piping" for system piping requirements.

2.11 SYSTEM REFRIGERANT PIPING

A. Comply with requirements in Section 232300 "Refrigerant Piping" for system piping requirements.

B. Refrigerant Piping:

1. Copper Tube: [ASTM B 280, Type ACR] <Insert material>.
2. Wrought-Copper Fittings: ASME B16.22.
3. Brazing Filler Metals: AWS A5.8/A5.8M.

C. Refrigerant Isolation Ball Valves:

1. Description: Uni-body full port design, rated for maximum system temperature and pressure, and factory tested under pressure to ensure tight shutoff. Designed for valve operation without removing seal cap.
2. Seals: Compatible with system refrigerant and oil. Seal service life of at least 20 years.
3. Valve Connections: Flare or sweat depending on size.

2.12 METAL HANGERS AND SUPPORTS

A. Copper Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of [galvanized or copper-coated steel] [stainless steel] <Insert material>.

2.13 PIPING AND TUBING INSULATION

A. Comply with requirements in Section 230719 "HVAC Piping Insulation" for system piping insulation requirements.

2.14 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect factory-assembled equipment.

B. Equipment will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports for historical record. Submit reports only if requested.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine products before installation. Reject products that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for piping and tubing to verify actual locations of connections before equipment installation.

D. Examine roughing-in for ductwork to verify actual locations of connections before equipment installation.

E. Examine roughing-in for wiring and conduit to verify actual locations of connections before equipment installation.

F. Examine walls, floors, roofs, and outdoor pads for suitable conditions where equipment will be installed.

G. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

H. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION, GENERAL

A. Clearance:

1. Maintain manufacturer's recommended clearances for service and maintenance.
2. Maintain clearances required by governing code.

B. Loose Components: Install components, devices, and accessories furnished by manufacturer, with equipment, that are not factory mounted.

1. Loose components shall be installed by system Installer under supervision of manufacturer's service representative.

C. Equipment Restraint Installation: Install equipment with seismic-restraint device. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

3.3 INSTALLATION OF INDOOR UNITS

A. Install units to be level and plumb while providing a neat and finished appearance.

B. Unless otherwise required by VRF HVAC system manufacturer, support ceiling-mounted units from structure above using threaded rods; minimum rod size of 3/8 inch.

C. Adjust supports of exposed and recessed units to draw units tight to adjoining surfaces.

D. Protect finished surfaces of ceilings, floors, and walls that come in direct contact with units. Refinish or replaced damaged areas after units are installed.

E. In rooms with ceilings, conceal piping and tubing, controls, and electrical power serving units above ceilings.

F. In rooms without ceiling, arrange piping and tubing, controls, and electrical power serving units to provide a neat and finished appearance.

G. Provide lateral bracing if needed to limit movement of suspended units to not more than 0.25 inch.

H. For floor- and wall-mounted units that are exposed, conceal piping and tubing, controls, and electrical power serving units within walls.

I. Attachment: Install hardware for proper attachment to supported equipment.

J. Grouting: Place grout under equipment supports and make bearing surface smooth.

K. Install outdoor units on support structures indicated on Drawings.

3.4 GENERAL REQUIREMENTS FOR PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping and tubing systems. Install piping and tubing as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping and tubing in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping and tubing at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping and tubing above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping and tubing to permit valve servicing.

F. Install piping and tubing at indicated slopes.

G. Install piping and tubing free of sags.

H. Install fittings for changes in direction and branch connections.

I. Install piping and tubing to allow application of insulation.

J. Install groups of pipes and tubing parallel to each other, spaced to permit applying insulation with service access between insulated piping and tubing.

K. Install sleeves for piping and tubing penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

L. Install escutcheons for piping and tubing penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.5 INSTALLATION OF SYSTEM CONDENSATE DRAIN PIPING

A. General Requirements for Drain Piping and Tubing:

1. Install a union in piping at each threaded unit connection.
2. Install an adjustable stainless-steel hose clamp with adjustable gear operator on unit hose connections. Tighten clamp to provide a leak-free installation.
3. If required for unit installation, provide a trap assembly in drain piping to prevent air circulated through unit from passing through drain piping. Comply with more stringent of the following:

    a. Details indicated on Drawings.
    b. Manufacturer's requirements.
    c. Governing codes.
    d. In the absence of requirements, comply with requirements of ASHRAE handbooks.

4. Extend drain piping from units with drain connections to drain receptors as indicated on Drawings. If not indicated on Drawings, terminate drain connection at nearest accessible location that is not exposed to view by occupants.
5. Provide each 90-degree change in direction with a Y- or T-fitting. Install a threaded plug connection in the dormant side of fitting or future use as a service cleanout.

B. Gravity Drains:

1. Slope piping from unit connection toward drain termination at a constant slope of not less than one percent.

C. Pumped Drains:

1. If unit condensate pump or lift mechanism is not included with an integral check valve, install a full-size check valve in each branch pipe near unit connection to prevent backflow into unit.

3.6 INSTALLATION OF REFRIGERANT PIPING

A. Install refrigerant piping according to ASHRAE 15 and governing codes.

B. Select system components with pressure rating equal to or greater than system operating pressure.

C. Install piping as short and direct as possible, with a minimum number of joints and fittings.

D. Arrange piping to allow inspection and service of equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

E. Unless otherwise required by VRF HVAC system manufacturer, slope refrigerant piping and tubing as follows:

1. Install horizontal hot-gas discharge piping and tubing with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps to entrain oil in vertical runs.
4. Liquid lines may be installed level.

F. When brazing, remove or protect components that could be damaged by heat.

G. Before installation, clean piping, tubing, and fittings to cleanliness level required by VRF HVAC system manufacturer.

H. Joint Construction:

1. Ream ends of tubes and remove burrs.
2. Remove scale, slag, dirt, and debris from inside and outside of tube and fittings before assembly.
3. Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

    a. Use Type BCuP (copper-phosphorus) alloy for joining copper fittings with copper tubing.
    b. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze.

3.7 INSTALLATION OF PIPING AND TUBING INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated. Installation to maintain a continuous vapor barrier.

B. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are unavailable, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3.8 ELECTRICAL INSTALLATION

A. Comply with requirements indicated on Drawings and in applicable Division 26 Sections.

B. To extent electrical power is required for system equipment, components, and controls, and is not indicated on Drawings and addressed in the Specifications, the design for such electrical power shall be delegated to VRF HVAC system provider.

1. Delegated design of electrical power to equipment, components and controls, and associated installation shall be included at no additional cost to Owner.

C. Connect field electrical power source to each separate electrical device requiring field electrical power. Coordinate termination point and connection type with Installer.

D. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

E. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding connections.

F. Install nameplate or acrylic label with self-adhesive back for each electrical connection indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated phenolic layers of black with engraved white letters. Letters at least 1/2 inch high.
2. Locate nameplate or label where easily visible.

G. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or revised in this Section.

1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.
2. Outlet boxes for cables shall be no smaller than 4 inches square by [1-1/2 inches] [2-1/8 inches] deep with extension ring sized to bring edge of ring to within 1/8 inch of the finished wall surface.
3. Flexible metal conduit shall not be used.

H. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

I. Install manufactured conduit sweeps and long-radius elbows if possible.

J. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

3.9 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.10 GROUNDING INSTALLATION

A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.

B. For low-voltage control cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.11 IDENTIFICATION

A. Identify system equipment, piping, tubing, and valves. Comply with requirements for identification specified in Section 230553 "Identification for HVAC Piping and Equipment."

B. Identify system electrical and controls components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Identify each control cable on each end and at each terminal with a number-coded identification tag. Each cable shall have a unique tag.

3.12 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage VRF HVAC system manufacturer's service representative to advise and assist installers; witness testing; and observe and inspect components, assemblies, and equipment installations, including controls and connections.

1. Field service shall be performed by a factory-trained and -authorized service representative of VRF HVAC system manufacturer whose primary job responsibilities are to provide direct technical support of its products.

a. Additional factory-authorized representatives may assist with completion of certain activities only if supervised by manufacturer's employee. A factory-authorized representative shall not provide assistance without manufacturer's employee supervision.

2. Manufacturer shall provide on-site visits during the course of construction at installation milestones indicated. System Installer shall coordinate each visit in advance to give manufacturer sufficient notice to plan the visit.

   a. First Visit: Kick-off meeting.
   b. Second Visit: At approximately 50 percent completion of system(s).
   c. Third Visit: Final inspection before system startup.

3. Kick-off Meeting:

   a. Meeting shall include system Installer and other related trades with sole purpose of reviewing VRF HVAC system installation requirements and close coordination required to make a successful installation.
   b. Meeting shall be held at Project site and scheduled at a mutually agreed to time that occurs before the start of any part of system installation.
   c. Meeting shall cover the following as a minimum requirement:

      1) Review of latest issue of Contract Documents, Drawings, and Specifications, relevant to VRF HVAC systems.
      2) Manufacturer's installation requirements specific to systems being installed.
      3) Review of all relevant VRF HVAC system submittals, including delegated-design submittals.
      4) Required field activities related installation of VRF HVAC system.
      5) Project team communication protocol, contact information, and exchange of responsibilities for each party involved, including manufacturer, supplier, system Installer, and other related trades.

4. Site Visits: Activities for each site visit shall include the following:

   a. Meet with VRF HVAC system Installer to discuss field activities, issues, and suggested methods to result in a successful installation.
   b. Offer technical support to Installer and related trades as related to VRF system(s) being installed.
   c. Review progress of VRF HVAC system(s) installation for strict compliance with manufacturer's requirements.
   d. Advise and if necessary assist Installer with updating related refrigerant calculations and system documentation.
   e. Issue a report for each visit, documenting the visit.

      1) Report to include name and contact information of individual making the visit.
      2) Date(s) and time frames while on-site.
      3) Names and contact information of people meeting with while on-site.
      4) Clearly identify and list each separate issue that requires resolution. For each issue, provide a unique identification number, relevant importance, specific location or equipment identification, description of issue, recommended corrective action, and follow-up requirements needed. Include a digital photo for clarification if deemed to be beneficial.

5. Final Inspection before Startup:

    a. Before inspection, Installer to provide written request to manufacturer stating the system is fully installed according manufacturer's requirements and ready for final inspection.
    b. All system equipment and operating components shall be inspected. If components are inaccessible for inspection, they shall be made accessible before the final inspection can be completed.
    c. Manufacturer shall provide a comprehensive inspection of all equipment and each operating component that comprise the complete system(s). Inspection shall follow a detailed checklist specific to each equipment and operating component.
    d. Inspection reports for indoor units shall include, but not be limited to, the following:

        1) Unit designation on Drawings.
        2) Manufacturer model number.
        3) Serial number.
        4) Network address, if applicable.
        5) Each equipment setting.
        6) Mounting, supports, and restraints properly installed.
        7) Proper service clearance provided.
        8) Wiring and power connections correct.
        9) Line-voltage reading(s) within acceptable range.
        10) Wiring and controls connections correct.
        11) Low-voltage reading(s) within an acceptable range.
        12) Controller type and model controlling unit.
        13) Controller location.
        14) Temperature settings and readings within an acceptable range.
        15) Humidity settings and readings within an acceptable range.
        16) Condensate removal acceptable.
        17) Fan settings and readings within an acceptable range.
        18) Unit airflow direction within an acceptable range.
        19) If applicable, fan external static pressure setting.
        20) Filter type and condition acceptable.
        21) Noise level within an acceptable range.
        22) Refrigerant piping properly connected and insulated.
        23) Condensate drain piping properly connected and insulated.
        24) If applicable, ductwork properly connected.
        25) If applicable, external interlocks properly connected.
        26) Remarks.

    e. Inspection reports for outdoor units shall include, but not be limited to, the following:

        1) Unit designation on Drawings.
        2) Manufacturer model number.
        3) Serial number.
        4) Network address, if applicable.
        5) Each equipment setting.
        6) Mounting, supports, and restraints properly installed.
        7) Proper service clearance provided.
        8) Wiring and power connections correct.
        9) Line-voltage reading(s) within acceptable range.
        10) Wiring and controls connections correct.

11) Low-voltage reading(s) within an acceptable range.
12) Condensate removal acceptable.
13) Noise level within an acceptable range.
14) Refrigerant piping properly connected and insulated.
15) Condensate drain piping properly connected and insulated.
16) Remarks.

f. Inspection reports for indoor, dedicated outdoor air ventilation units shall include, but not be limited to, the following:

1) Unit designation on Drawings.
2) Manufacturer model number.
3) Serial number.
4) Network address, if applicable.
5) Each equipment setting.
6) Mounting, supports, and restraints properly installed.
7) Proper service clearance provided.
8) Wiring and power connections correct.
9) Line-voltage reading(s) within acceptable range.
10) Wiring and controls connections correct.
11) Low-voltage reading(s) within an acceptable range.
12) Controller type and model controlling unit.
13) Controller location.
14) Temperature settings and readings within an acceptable range.
15) Humidity settings and readings within an acceptable range.
16) Condensate removal acceptable.
17) Fan settings and readings within an acceptable range.
18) Fan external static pressure setting.
19) Filter type and condition acceptable.
20) Noise level within an acceptable range.
21) Refrigerant piping properly connected and insulated.
22) Condensate drain piping properly connected and insulated.
23) Automatic dampers properly installed and operating.
24) Ductwork properly connected.
25) If applicable, external interlocks properly connected.
26) Remarks.

g. Inspection reports for energy recovery ventilators shall include, but not be limited to, the following:

1) Unit designation on Drawings.
2) Manufacturer model number.
3) Serial number.
4) Network address, if applicable.
5) Each equipment setting.
6) Mounting, supports, and restraints properly installed.
7) Proper service clearance provided.
8) Wiring and power connections correct.
9) Line-voltage reading(s) within acceptable range.
10) Wiring and controls connections correct.
11) Low-voltage reading(s) within an acceptable range.
12) Controller type and model controlling unit.
13) Controller location.
14) Temperature settings and readings within an acceptable range.
15) Humidity readings.

16) Condensate removal acceptable.
17) Fan settings and readings within an acceptable range.
18) Fan external static pressure setting.
19) Filter type and condition acceptable.
20) Noise level within an acceptable range.
21) Automatic dampers properly installed and operating.
22) Ductwork properly connected.
23) If applicable, external interlocks properly connected.
24) Remarks.

h. Inspection reports for hydronic units shall include, but not be limited to, the following:

1) Unit designation on Drawings.
2) Manufacturer model number.
3) Serial number.
4) Network address, if applicable.
5) Each equipment setting.
6) Mounting, supports, and restraints properly installed.
7) Proper service clearance provided.
8) Wiring and power connections correct.
9) Line-voltage reading(s) within acceptable range.
10) Wiring and controls connections correct.
11) Low-voltage reading(s) within an acceptable range.
12) Controller type and model controlling unit.
13) Controller location.
14) Temperature settings and readings within an acceptable range.
15) Condensate removal acceptable.
16) Noise level within an acceptable range.
17) Refrigerant piping properly connected and insulated.
18) Hydronic piping properly connected and insulated.
19) Proof of water flow checked for proper operation.
20) Condensate drain piping properly connected and insulated.
21) If applicable, external interlocks properly connected.
22) Remarks.

i. Installer shall provide manufacturer with the requested documentation and technical support during inspection.
j. Installer shall correct observed deficiencies found by the inspection.
k. Upon completing the on-site inspection, manufacturer shall provide a written report with complete documentation describing each inspection step, the result, and any corrective action required.
l. If corrective action is required by Installer that cannot be completed during the same visit, provide additional visits, as required, until deficiencies are resolved and systems are deemed ready for startup.
m. Final report shall indicate the system(s) inspected are installed according to manufacturer's requirements and are ready for startup.

B. Perform the following tests and inspections with the assistance of manufacturer's service representative:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Refrigerant Tubing Positive Pressure Testing:

1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.
2. After completion of tubing installation, pressurize tubing systems to a test pressure of not less than 1.5 times VRF HVAC system operating pressure, but not less than 600 psig, using dry nitrogen.
3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of 24 hours. Allowance for pressure changes attributed to changes in ambient temperature are acceptable.
4. Prepare test report to record the following information for each test:

    a. Name of person starting test, company name, phone number, and e-mail address.
    b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
    c. Detailed description of extent of tubing tested.
    d. Date and time at start of test.
    e. Test pressure at start of test.
    f. Outdoor temperature at start of test.
    g. Name of person ending test, company name, phone number, and e-mail address.
    h. Date and time at end of test.
    i. Test pressure at end of test.
    j. Outdoor temperature at end of test.
    k. Remarks:

5. Submit test reports for Project record.

D. Refrigerant Tubing Evacuation Testing:

1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.
2. After completion of tubing positive-pressure testing, evacuate tubing systems to a pressure of [500] <Insert value> microns.
3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of [one] <Insert number> hour(s) with no change.
4. Prepare test report to record the following information for each test:

    a. Name of person starting test, company name, phone number, and e-mail address.
    b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
    c. Detailed description of extent of tubing tested.
    d. Date and time at start of test.
    e. Test pressure at start of test.
    f. Outdoor temperature at start of test.
    g. Name of person ending test, company name, phone number, and e-mail address.
    h. Date and time at end of test.
    i. Test pressure at end of test.

j. Outdoor temperature at end of test.
k. Remarks:

5. Submit test reports for Project record.
6. Upon successful completion of evacuation testing, system shall be charged with refrigerant.

E. System Refrigerant Charge:

1. Using information collected from the refrigerant tubing evacuation testing, system Installer shall consult variable refrigerant system manufacturer to determine the correct system refrigerant charge.
2. Installer shall charge system following VRF HVAC system manufacturer's written instructions.
3. System refrigerant charging shall be witnessed by system manufacturer's representative.
4. Total refrigerant charge shall be recorded and permanently displayed at the system's outdoor unit.

F. Products will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.13 STARTUP SERVICE

A. Engage a VRF HVAC system manufacturer's service representative to perform system(s) startup service.

1. Service representative shall be a factory-trained and -authorized service representative of VRF HVAC system manufacturer.
2. Complete startup service of each separate system.
3. Complete system startup service according to manufacturer's written instructions.

B. Startup checks shall include, but not be limited to, the following:

1. Check control communications of equipment and each operating component in system(s).
2. Check each indoor unit's response to demand for cooling and heating.
3. Check each indoor unit's response to changes in airflow settings.
4. Check each indoor unit, HRCU, and outdoor unit for proper condensate removal.
5. Check sound levels of each indoor and outdoor unit.

C. Installer shall accompany manufacturer's service representative during startup service and provide manufacturer's service representative with requested documentation and technical support during startup service.

1. Installer shall correct deficiencies found during startup service for reverification.

D. System Operation Report:

1. After completion of startup service, manufacturer shall issue a report for each separate system.
2. Report shall include complete documentation describing each startup check, the result, and any corrective action required.

3. Manufacturer shall electronically record not less than two hours of continuous operation of each system and submit with report for historical reference.

    a. All available system operating parameters shall be included in the information submitted.

E. Witness:

1. Invite Commissioning Agent to witness startup service procedures.
2. Provide written notice not less than 20 business days before start of startup service.

3.14 ADJUSTING

A. Adjust equipment and components to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust initial temperature and humidity set points. Adjust initial airflow settings and discharge airflow patterns.

C. Set field-adjustable switches and circuit-breaker trip ranges according to VRF HVAC system manufacturer's written instructions, and as indicated.

D. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.15 PROTECTION

A. Protect products from moisture and water damage. Remove and replace products that are wet, moisture damaged, or mold damaged.

B. Protect equipment from physical damage. Replace equipment with physical damage that cannot be repaired to new condition. Observable surface imperfections shall be grounds for removal and replacement.

C. Protect equipment from electrical damage. Replace equipment suffering electrical damage.

D. Cover and seal openings of equipment to keep inside of equipment clean. Do not remove covers until finish work is complete.

3.16 DEMONSTRATION

A. Contractor shall engage a VRF HVAC system manufacturer's factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain entire system.

B. Instructor:

1. Instructor shall be factory trained and certified by VRF HVAC system manufacturer with current training on the system(s), equipment, and controls that are installed.

C. Schedule and Duration:

1. Schedule training with Owner at least 20 business days before first training session.
2. Training shall occur before Owner occupancy.
3. Training shall be held at mutually agreed date and time during normal business hours.
4. Perform not less than eight total hours of training.

D. Location: Owner shall provide a suitable on-site location to host classroom training.

E. Training Attendees: Assume three people.

F. Training Attendance: For record purposes, document training attendees at the start of each new training session. Record attendee's name, signature, phone number, and e-mail address.

G. Training Format: Individual training modules shall include classroom training followed by hands-on field demonstration and training.

H. Training Materials: Provide training materials in electronic format to each attendee.

1. Include instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
2. Video record each classroom training session and submit an electronic copy to Owner before requesting Owner acceptance of training.

I. Acceptance: Obtain Owner written acceptance that training is complete and requirements indicated have been satisfied.

END OF SECTION 238129

SECTION 238216.14 - ELECTRIC-RESISTANCE AIR COILS

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:

1. Electric-resistance air coils.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil.
2. Include rated capacities, operating characteristics, and pressure drops for each air coil.

B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Coil Assembly: Comply with UL 1995.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

C. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

D. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5, "Systems and Equipment," and Section 7, "Construction and Startup."

E. Equally balance heater electrical load for each step across all electrical phases.

F. Part-Load Operation: Provide arrangement with operation staged for uninterrupted operation over the full range of airflow down to the minimum airflow indicated.

2.2 ELECTRIC-RESISTANCE AIR COILS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Brasch Manufacturing Co., Inc.
2. Chromalox, Inc.
3. INDEECO.

B. Source Limitations: Obtain electric-resistance air coils from single source from single manufacturer.

C. Heating Elements:

1. Open Elements:

a. Open-coil resistance wire of 80 percent nickel and 20 percent chromium; supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in a frame.
b. Safety Screens: Install safety screens to protect operators from accidentally coming into direct connect with elements.

D. Frame: Galvanized steel; minimum 0.079 inch thick for flanged mounting. Include intermediate element support brackets equally spaced at a maximum of 36 inches o.c. across electric-resistance air coil.

E. Terminal Box/Control Panel: [Unit mounted] [Remote mounted] [Unit or remote mounting arrangement indicated on Drawings]; with disconnection means and overcurrent protection.

1. Enclosure: NEMA 250, Type 12 enclosure complying with UL 50.
2. Full-face-hinged door with lock and key latching device(s).
3. Factory insulate terminal box to prevent condensation from occurring within box.
4. Install a laminated elementary wiring diagram on inside face of heater control panel door or in another protected location than visible be service personnel. Wiring diagram to match installation.

F. Controls:

1. Safety Controls: Each heater is to be provided with the following factory-mounted safety controls:

a. Disk-type thermal cutout switch with automatic reset.
b. Airflow Proving Switch: Pressure differential type; with pressure range selected to ensure reliable operation throughout full range of air-handling unit airflow down to minimum airflow indicated.

2. SCR Control: Silicone-controlled rectifier (SCR) for 100 percent stepless capacity control.
3. Remote Monitoring and Control: Include control devices necessary to interface with remote-control signals, including the following:

a. Heater on/off control.
b. Monitoring heater on/off status.
c. High-temperature alarm.
d. Low-airflow alarm.
e. Heater capacity control.

G. Electrical:

1. Single-Point Field Power Connection: Install and wire the heater to accommodate a single field electrical connection for electrical power.
2. Disconnecting Means: Provide each heater with a main electrical power connection, door mounted and interlocking, and disconnecting means to prevent access into panel, unless switched to the off position.

a. [Fused disconnect switch] [Nonfused disconnect switch] [Circuit breaker] with lockable handle.

3. Factory install and wire branch circuit fusing or circuit breakers in accordance with NFPA 70.
4. Pilot Lights: Include labeled pilot lights on face of control panel for the following:

a. Power on.

5. Terminations: Wire terminations and field interface terminations to labeled terminal strips.
6. Control Transformer: Size control circuit transformer for load.
7. Labeling: Label each electrical device with a laminated phenolic tag.

H. Nameplate: Include the following data:

1. Manufacturer name, address, telephone number, and website address.
2. Manufacturer model number.
3. Serial number.
4. Manufacturing date.
5. Coil identification (indicated on Drawings).

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install coils level and plumb.

B. Install coils in metal ducts and casings constructed in accordance with SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

C. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least [1/2 inch] <Insert dimension> high.

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

C. Install nameplate for each control connection, indicating field control panel designation and I/O control designation feeding connection.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections with the assistance of a factory-authorized service representative.

D. Tests and Inspections:

1. Operational Test: After electrical circuitry has been energized, operate electric coils to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Prepare test and inspection reports.

END OF SECTION 238216.14

SECTION 238239.13 - CABINET UNIT HEATERS

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 cabinet unit heaters with centrifugal fans and electric-resistance heating coils.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. DDC: Direct digital control.

C. PTFE: Polytetrafluoroethylene plastic.

D. TFE: Tetrafluoroethylene plastic.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include location and size of each field connection.
4. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
5. Wiring Diagrams: Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Method of attaching hangers to building structure.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 PRODUCTS

2.1 DESCRIPTION

A. Factory-assembled and -tested unit complying with AHRI 440.

B. 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.

C. Comply with UL 2021.

2.2 PERFORMANCE REQUIREMENTS

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

C. Seismic Performance: Cabinet unit heaters shall withstand the effects of earthquake motions determined according to [ASCE/SEI 7] <Insert requirement>.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[and the unit will be fully operational after the seismic event]."

2.3 CABINETS

A. Material: Steel with [factory prime coating, ready for field painting] [baked-enamel finish with manufacturer's standard paint, in color selected by Architect] [baked-enamel finish with manufacturer's custom paint, in color selected by Architect].

1. Vertical Unit, Exposed Front Panels: Minimum 0.0677-inch- thick galvanized sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.

2.4 FILTERS

A. Material: Washable Foam, MERV 3.

2.5 COILS

A. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, mounted in ceramic inserts in galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.

2.6 CONTROLS

A. Fan and Motor Board: Removable.

1. Fan: Forward curved, [high static,]double width, centrifugal, directly connected to motor; thermoplastic or painted-steel wheels and aluminum, painted-steel, or galvanized-steel fan scrolls.
2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
3. Wiring Terminations: Connect motor to chassis wiring with plug connection.

B. Control devices and operational sequences are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

C. Basic Unit Controls:

1. Control voltage transformer.
2. Wall -mounted thermostat with the following features:
3. Wall -mounted temperature sensor.
4. Data entry and access port.

a. Output data includes room temperature, supply-air temperature, entering-water temperature, operating mode, and status.

D. Interface with DDC System for HVAC Requirements:

1. Interface relay for scheduled operation.
2. Interface relay to provide indication of fault at central workstation.
3. Interface shall be BAC-net compatible for central DDC system for HVAC workstation and include the following functions:

E. Electrical Connection: Factory-wired motors and controls for a single field connection.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas to receive cabinet unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for [piping and]electrical connections to verify actual locations before unit-heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall boxes in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Section 079200 "Joint Sealants."

B. Install cabinet unit heaters to comply with NFPA 90A.

C. Suspend cabinet unit heaters from structure with elastomeric hangers[and seismic restraints]. Vibration isolators[and seismic restraints] are specified in [Section 230548 "Vibration and Seismic Controls for HVAC."] [Section 230548.13 "Vibration Controls for HVAC."]

D. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

E. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.3 CONNECTIONS

A. Comply with safety requirements in UL 1995.

B. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of cabinet unit heater. Hydronic specialties are specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."

C. Unless otherwise indicated, install union and gate or ball valve on steam-supply connection and union, strainer, steam trap, and gate or ball valve on condensate-return connection of cabinet unit heater. Steam specialties are specified in Section 232216 "Steam and Condensate Heating Piping Specialties."

D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections[with the assistance of a factory-authorized service representative]:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature set points.

END OF SECTION 238239.13

SECTION 260000 – ELECTRICAL GENERAL REQUIREMENTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. All work under this Section shall comply with the requirements of General Conditions, Supplemental Conditions, Special Conditions and Division 1 - General Requirements, and shall include all Sections of Division 26 and shall apply to all Work specified, indicated in the Drawings, and as required to furnish a complete installation of electrical systems for the Project. Review all Sections of the Specifications for related work and coordinate the work of this Section with all other Sections.

1.2 SUMMARY

A. Section includes common work results related to all Division 26 Sections.

B. Furnish all labor, services, materials, tools, equipment, appliances, facilities, transportation and incidental work and appurtenances required to furnish a complete and properly operating system.

C. The Contractor shall refer to the architectural interior details, floor plans, elevations, and the structural and other Contract Drawings and shall coordinate the work with that of the other trades to avoid interference. The plans are diagrammatic and show the general arrangement of the conduit, panels, transformers and equipment. All dimensions and existing conditions shall be the responsibility the Contractor. Before proceeding with work check and verify all dimensions.

D. The Contractor shall assume all responsibility for fitting of materials and equipment to other parts of equipment and structure. Make adjustments that may be necessary or as requested, in order to resolve space problems, preserve headroom, and avoid architectural openings, structural members and work of other trades. Where existing pipes, conduits and/or ducts prevent installation of new work as indicated, relocate, or arrange for relocation with the applicable trades, existing pipes, conduits and/or ducts.

E. Where the project involves interface with existing building and site systems, the Consultant has used reasonable care to identify existing utilities and services. The Contractor is responsible to thoroughly familiarize themselves with existing conditions and be aware that in some cases information is not available i.e. concealed conditions, which exist in the existing building affected by this work.

F. Documents do not represent to show or list every item to be provided. When an item not shown or listed, is necessary for proper operation of the system and/or equipment, the Contractor shall provide the item which will allow the system to function properly at no increase in Contract Sum.

G. Maintain integrity of fire-rated construction where penetrated by electrical work.

H. Work shall include, but shall not be limited to, the following:
   1. Coordinate maintenance of electrical services during construction with Owner and Owner's representative.

2. Hoisting and rigging required to complete work of this section.
3. Sleeves, inserts and hangers.
4. Equipment bases and supports.
5. Vibration isolators, and seismic restraints.
6. Low Voltage Distribution System
7. Emergency Power Systems and Distribution
8. Electrical Grounding Systems
9. Lightning Protection Systems
10. Interior Lighting System
11. Exterior Lighting System
12. Panelboard and major component identification.
13. Instruction manual and start up instructions.
14. Testing and balancing.
15. Commissioning.
16. Cleaning.
17. Power wiring to all DDC control panels and controls.

I. Related work specified elsewhere: The following work, unless otherwise noted is included in this section shall be performed in Division 26:

1. Fire Alarm Systems. See Division 28
2. Auxiliary Radio Communications Systems. See Division 28

J. QUALITY ASSURANCE

K. General:

1. All equipment and accessories shall be the product of a manufacturer regularly engaged in its manufacturer.
2. All equipment and accessories shall be new and free from defects.
3. Supply all equipment and accessories in compliance with the applicable standards listed in this Section and with all applicable National, State and Local Codes.
4. All items of a given type shall be the product of the same manufacturer.
5. Install work by craftsmen skilled in trade involved and by apprentices as indicated in the general conditions. Rough work will be rejected.
6. The subcontractor must, within the last five years, prior to the bid opening, have successfully completed in a timely fashion at least three projects similar in scope and type to the required work.

L. Requirement of regulatory agencies:

1. In accordance with requirements of Division 1 and as specified herein.
2. Nothing in the Drawings or Specifications shall be construed to permit Work not conforming to applicable laws, ordinances, rules or regulations.
3. When Drawings or Specifications exceed requirements of applicable laws, ordinances, rules or regulations, Drawings and Specifications take precedence.
4. It is not the intent of Drawings and Specifications to repeat requirements of codes except where necessary for completeness or clarity.
5. If any of the requirements of the above are in conflict with one another, or with the requirements of these specifications, the most stringent requirements shall govern.

1.3 APPLICABLE REGULATIONS, CODES, PUBLICATION, PERMITS AND FEES

A. Materials and equipment shall be manufactured, installed and tested as specified in latest editions of applicable publications, standards, rulings and determinations of:

1. Local and state building, plumbing, mechanical, electrical, fire and health department codes.
2. American National Standards (ANSI).
3. American Society of Testing and Materials (ASTM).
4. Underwriter's Laboratories (UL).
5. National Electric Code (NEC)
6. Insulated Cable Engineers Association (ICEA).
7. Institute of Electrical and Electronic Engineers (IEEE).
8. National Electrical Manufacturers' Association (NEMA).
9. National Electrical Testing Association, Inc (NETA).
10. National Fire Protection Association (NFPA).
11. Occupational Safety and Health Act (OSHA)
12. Certified Ballast Manufacturers (CBM).
13. Owner's Insurance Underwriter.

B. All materials and equipment shall be listed by Underwriters" Laboratories (UL), and approved by ANSI, ASTM, and NEC for intended service.

C. Most recent editions of applicable specifications and publications of the following organizations form part of these Contract Documents.

1. American National Standards Institute (ANSI)
2. American Society of Testing and Materials (ASTM).
3. Underwriter's Laboratories (UL).
4. National Electric Code (NEC)
5. Insulated Cable Engineers Association (ICEA).
6. Institute of Electrical and Electronic Engineers (IEEE).
7. National Electrical Manufacturers' Association (NEMA).
8. National Electrical Testing Association, Inc (NETA).
9. National Fire Protection Association (NFPA).
10. Occupational Safety and Health Act (OSHA)
11. Certified Ballast Manufacturers (CBM)
12. Illuminating Engineering Society (IES)

D. Specific reference is made to following NFPA codes which contain an exceptionally high quantity of mechanical, electrical, and fire protection requirements.

1. No. 20 - Installation of centrifugal fire pumps.
2. No. 70 - National Electric Code
3. No. 72D - Proprietary Protective Signaling Systems
4. No. 72E - Automatic Fire Detectors

E. Conform to all rules, regulations, standards, ordinances and laws of local, state, and Federal governments and other authorities that have legal jurisdiction over the site.

F. Prior to commencement of work, notify State and applicable authorities as required and submit all of the applicable notifications for construction, operation and demolition. Secure required permits and inspections from any of the authorities having jurisdiction, for this work and pay for all fees required for permits, inspections and review, including special agency construction.

G. Include all utility and local building department charges for providing temporary and permanent electric services to buildings.

H. Provide Owner, Owner's Representative and Inspectors from any of the authorities / agencies having jurisdiction access to work at all times.

I. Contractor shall be responsible for all law violations caused by the work under this Division. Notify Construction Manager in writing when a discrepancy occurs between code requirements and work shown on drawings and resolve matter before proceeding with work.

J. When requirements cited in this specification conflict with each other or with Contract Documents, most stringent shall govern work. Consultants may relax this requirement when such relaxation does not violate ruling of authorities that have jurisdiction. Approval for such relaxation shall be obtained in writing.

K. Make corrections in the work as required by the Owner's Representative or Inspector to pass local regulations.

L. Contractor shall deliver to the Construction Manager any and all certificates of inspections, permits, and approvals. Contractor shall submit final inspection certificates signed by governing authorities to the Owner.

M. Make all necessary submissions to the Department of Environmental Protection, Bureau of Air Resources and Management, Department of Labor and Industry and other agencies having jurisdiction. Pay all required fees for review, registration and sign off.

1.4 DEFINITIONS

A. "Provide" means "furnish and install", complete, the specified material, equipment or other item and perform all required labor to make a finished and properly operational installation.

B. "Furnish" means to purchase and deliver to project site complete with all appurtenance and support. "Install means to unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project

C. "Consultant" means "Prime Design Consultant".An individual or organization engaged by the owner or the architect to render professional engineering consulting services complementing or supplementing the architect's services concerning the content of the Mechanical, Electrical, Plumbing & Fire Protection sections of specifications.

D. "Owner" means the individual or entity with whom Contractor has entered into the Agreement for whom the Work is to be performed

E. “Construction Manager Advisor" or “CMA" means the Construction Manager that provides services to advise the Owner and Architect on design and materials decisions during the design and document development process. The CMA coordinates the entire design process using his skills and knowledge of construction to clarify cost and time considerations of design decisions, to advise on feasibility of single, multiple-contract or fast-track delivery systems, recommend the construction process, and to handle the bidding and award, as well as to manage the construction of the Project.

F. “Construction Manager Constructor or “CMC means the Construction Manager that in addition to acting as an advisor to the Owner during a design period, assumes responsibility for the construction of the Project. The CMC become contractually bound to provide the labor and material for the Project. The CMC may also serve as administrator of multiple prime contract construction; however, some states prohibit that practice.

G. General Contractor/ Prime Contractor means the contractor who contracts with a property owner and, in turn, employs a subcontractor or subcontractors to perform some of all of the work.

H. “Contractor" or “Subcontractor" means the trade contractor responsible for the work in this Division of the specification.

I. “Owner’s Representative means the Consultant, Engineer, or other Specialty Consultant retained by the Owner.

J. “RFI" means “Contractor’s Request for Information”.

K. "Above Grade": Not buried in the ground and not embedded in concrete slab on ground.

L. “Accessible”: Ability to perform recommended maintenance without removal of services or equipment and requiring no special platforms.

M. "Actuating" or "Control" Devices: Automatic sensing and switching devices such as thermostats, pressure, float, electro-pneumatic switches and electrodes controlling operation of equipment.

N. "Below Grade": Buried in the ground or embedded in concrete slab on ground.

O. "Concealed": Embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures. In general, any item not visible or directly accessible.

P. "Connect": Complete hook-up of item with required service.

Q. "Exposed": Not installed underground or "concealed."

R. "Indicated," "Shown" or " "Noted": As indicated, shown or noted on Drawings or Specifications.

S. "Install": To erect, mount and connect complete with related accessories.

T. "Piping": Pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation, and related items.

U. "Reviewed," "Satisfactory" or "Directed": As reviewed, satisfactory, or directed by or to Architect/Engineer/Owner.

V. "Rough-In": Provide all indicated services in the necessary arrangement suitable for making final connections to fixture or equipment.

W. "Shall": An exhortation or command to complete the specified task.

X. "Similar" or "Equal": Of base bid manufacture, equal in materials, weight, size, design, and efficiency of specified products.

Y. "Supply": To purchase, procure, acquire and deliver complete with related accessories.

Z. “Typical" or “Typ”: Exhibiting the qualities, traits, or characteristics that identify a kind, class, number, group or category. Of or relating to a representative specimen. Application shall apply to all other similarly identified on plan or detail.

AA. "Will": A desire to complete the specified task. Allows some flexibility in application as opposed to "Shall."

BB. "Wiring": Raceway, fittings, wire, boxes and related items.

CC. "Work": Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.

DD. Reference by abbreviation may be made in the specifications and the Contract Drawings for Mechanical and Electrical Work in accordance with the following list:

1. HVAC Heating, Ventilating and Air Conditioning
2. GC General Contractor
3. AWG American Wire Gauge
4. USS United States Standards
5. ASTM American Society of Testing Materials
6. ASA American Standards Association
7. AC: Alternating Current.
8. AIC: Ampere Interrupting Capacity.
9. ADA: Americans with Disabilities Act.
10. ANSI: American National Standards Institute.
11. AWG: American Wire Gauge.
12. CBM: Certified Ballast Manufacturers.
13. DC: Direct Current.
14. ETL: Electrical Testing Laboratory.
15. HID: High Intensity Discharge.
16. HP: Horsepower.
17. ICEA: Insulated Cable Engineers Association
18. IEEE: Institute of Electrical and Electronic Engineers.
19. NEMA: National Electrical Manufacturers' Association.
20. NETA: National Electrical Testing Association, Inc.
21. NFPA: National Fire Protection Association.
22. OSHA: Occupational Safety and Health Act.
23. PVC: Polyvinyl chloride.

U

1.5 SCOPE

A. Perform work and provide material and equipment as shown on the drawings and/or as specified and/or as indicated in this section of the specifications. Completely coordinate all work of this section with work of other trades and provide a complete and fully functional installation.

B. Drawings and Specifications form complimentary requirements; provide work specified and not shown, and work shown and not specified as though explicitly require by both. Although work is not specifically shown or specified, provide supplementary or miscellaneous items, appurtenances, devices and materials obviously necessary for sound, secure and complete installation.

C. Give notices, file plans, obtain permits and licenses, pay fees and back-charges, and obtain necessary approvals from authorities that have jurisdiction as required to perform work in accordance with all legal requirements and with Specifications, Drawings, Addenda and Change Orders, all of which are part of Contract Documents.

D. Contractor shall be responsible with obtaining all the final inspection as required by Local Code and ordinances.

1.6 CONTRACT DOCUMENTS

A. Listing of Documents does not limit responsibility of determining full extent of work required by these Contract Documents. Refer to the Consultant's, Electrical, Mechanical, Plumbing and Fire Protection, Structural, Site Utility and all other drawings and other sections that types of and work of other trades with which work of this section must be coordinated.

B. Except where modified by a specific notation to the contrary; it shall be understood that the indication and/or description of any item, in the drawings or specifications or both, carries with it the instruction to furnish and install the item, regardless of whether or not this instruction is explicitly stated as part of the indication or description.

C. Items referred to in singular number in Contract Documents shall be provided in quantities necessary to complete work.

D. Drawings are diagrammatic. They are not intended to be absolutely precise; they are not intended to specify coordinated routings and component. The purpose of the document is to indicate systems concept, the main components of the systems, and the approximate geometric relationships. Based on the systems concept, the main components and the approximate geometrical relationships, the contractor shall provide all other components and materials necessary to make the systems fully complete and operational.

E. Information and components shown on riser diagrams, but not shown on plans, and vice versa, shall apply and be provided as if expressly required on both.

F. Data that may be furnished electronically by the Consultant is diagrammatic. Such electronically furnished information is subject to the same limitation of precision as heretofore described. If furnished, such data is for convenience and generalized reference, and shall not be substitute for Consultant's sealed or stamped construction documents.

1.7 ELECTRONIC MEDIA FILES

A. Construction drawings for this project have been prepared utilizing Autodesk Revit.

B. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.

C. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Release form provided by Buro Happold.

D. The electronic contract documents can be used to assist in the preparation of shop drawings and as-built drawings however the electronic media files obtained from Buro Happold are for reference only. The information may not be used in whole or in part for any other project.

E. The drawings prepared for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.

F. The use of the electronic media documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.

G. The information is provided to expedite the project and assist the Contractor with no guarantee by Buro Happold as to the accuracy or correctness of the information provided. Buro Happold accepts no responsibility or liability for the Contractor's use of these documents.

1.8 COORDINATION DRAWINGS

A. The General Contractor shall appoint a BIM Coordination Manager to prepare a BIM Execution Plan developed specifically for the project, and based on the Computer Integrated Construction (CIC) Research Program's BIM Planning procedures. The BIM Execution Plan will establish the protocols, expected levels of development, and authorized uses of Building Information Models on this Project and assigns specific responsibility for the development of each Model Element to a defined Level.

B. Clash Detection: Perform three-dimensional component conflict analysis as part of coordination process with all other trades, including but not limited for Mechanical, Plumbing, Fire Protection and Electrical. Resolve component conflicts prior to submittal of shop drawings. Indicate where conflict resolution requires modification of design requirements by Construction Manager.

C. A single set of coordination drawings shall be mutually prepared by all mechanical, electrical, plumbing and fire protection trades.

D. The initiation of these drawings begins with Sheet Metal Subcontractor.

E. The Sheet Metal Subcontractor shall prepare a complete set of electronic background drawings at scale not less than 3/8" equals 1'-0", showing structure and other information as needed for coordination. He shall show sheet metal layout thereon. These will be Coordination Drawings.

F. Each of the mechanical, electrical and other specialty trade shall add its work to these background drawings with appropriate elevations and grid dimensions. Specialty trade information is require for fan rooms and mechanical rooms, horizontal exits from duct shafts, crossovers, and for spaces in and above ceilings where congestion of work may occur such as corridors, and even entire floors. Drawings shall indicate horizontal and vertical dimensions, to avoid interference with structural framing, ceilings, partitions, and other services.

G. Each specialty trade shall sign and date each coordination drawing. Return drawing to the Sheet Metal Subcontractor, who shall route them sequentially to all specialty trades.

H. Where conflicts occur with placement of materials of various trades, the Sheet Metal Subcontractor will be responsible to coordinate the available space to accommodate all trades. Any resulting adjustments shall be initialed and dated by specialty trade. The Sheet Metal Subcontractor shall then final date and sign each drawing. If he cannot resolve conflicts, the decision of the General Contractor/Construction Manager shall be final.

I. A Subcontractor who fails to promptly review and incorporate his work on the drawings shall assume full responsibility of any installation conflicts affecting his work and of any schedule ramifications.

J. Sheet Metal Subcontractor shall make prints of all coordination drawings. Fabrication shall not start until such transparencies of completed coordination drawings are received by the Consultant/Engineer. .

K. The review of coordination drawings shall not diminish responsibility under this Contract for final coordination of installation and maintenance clearances of all systems and equipment with the other trades, structural and other work.

L. After review:

1. After review of coordination drawings, the method used to resolve interferences not previously identified shall be as in “MODIFICATIONS IN LAYOUT” above.
2. All changes to reviewed coordination drawings shall be in writing by the Consultants/Engineer prior to start of work in affected area.

M. Distribution of Coordination Drawings - The Sheet Metal Subcontractor shall provide the following distribution of documents:

1. One sepia (reproducible) of each Coordination Drawing to each specialty trade and affected Contractor for their use.
2. One reproducible of each Coordination drawing to Owner.
3. One sepia (reproducible) of each coordination drawing to the General Contractor/Construction Manager.
4. The above documents can be submitted as electronic media upon agreement of all parties.

N. ALL FIREWALLS AND SMOKE PARTITIONS SHALL BE HIGHLIGHTED ON COORDINATION DRAWINGS FOR APPROPRIATE COORDINATION.

O. The main paths of egress and for equipment removal from main mechanical and electrical rooms must be clearly shown on coordination drawings.

P. Coordination Drawings shall include, but not limited to:

1. Plumbing systems, piping and equipment.
2. HVAC piping, systems and equipment.
3. Control systems.
4. Electrical distribution, systems and equipment.
5. Lighting systems and fixtures.
6. Sheet metal work, components and accessories, costs and boxes in terminals, etc.
7. Fire protection and sprinkler system, piping and heads.
8. Structural.
9. Electrical Equipment Room layouts.
10. Environmental Rooms and associated refrigeration/heating systems.
11. Partition/room layout.
12. Ceiling tile and grid.
13. Access panels.
14. Smoke and fire dampers.
15. Roof drain piping.
16. Major electrical conduit runs, panel-boards, feeder conduit and racks of branch conduit.
17. Above ceiling miscellaneous metal.
18. Heat tracing of piping.
19. Minimum access space requirements for all equipment for both installation and maintenance.
20. All conduit runs encased in structural walls or floors.

Q. Product Selection for Restricted Space: Drawings indicate maximum allowed dimensions for basis of design electrical equipment, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

R. 3D Assets: The contractor shall hand over all digital data files related to the BIM execution plan at the end of the construction process, including all, but not limited to the shop drawings, as built conditions and native 3D BIM file.

1.9 REVIEW OF CONTRACT DOCUMENTS AND SITE

A. With the submission of his bid, Contractor shall give written notice to the Owner of any materials or apparatus believed inadequate or unsuitable, in violation of laws, ordinances, rules or regulations of Authorities having jurisdiction, and any necessary items of work omitted. In the absence of such written notice it is mutually agreed that the Contractor has included the cost of all required items in his proposal for a complete project.

B. Contractor shall acknowledge that he has examined the Plans, Specifications and Site, and from his own investigations he has satisfied himself as to the nature and location of the work; the general and local conditions, particularly those bearing upon transportation, disposal, handling and storage of materials; availability of labor, water, electric power, roads and uncertainties of weather; the conformation and condition of the ground; the character, quality and quantity of surface and subsurface materials to be encountered; the character of equipment and facilities needed preliminary to and during the execution of the work; all federal, state, county, township and municipal laws, ordinances and regulations particularly those relating to employment of labor, rates of wages, and construction methods; and all other matters which can in any way affect work or the cost thereof under this Contract. Any failure by the Contractor to acquaint himself with the available information concerning these conditions will not relieve him from the responsibility for estimating properly the difficulty or cost of successfully performing the work.

C. The location and elevation of the underground utilities, such as sewers, electrical power, water piping, steam and steam condensate return piping, conduit, etc., is as exact as can be determined from available information and its accuracy cannot be guaranteed. Exact location and elevation of these services shall be verified prior to excavation or installation of any portion of the work indicated. Exercise special care when excavating at or near the general location of underground utilities to avoid damage to the utility services. The Contractors is responsible to insure worker safety.

D. The contractor shall also acknowledge having been to the site and examined conditions under which work must be performed including preparatory work done under other Sections or other Contracts or by the Owner. Report conditions to the Consultant. Do not proceed until defects have been corrected and conditions are satisfactory. Commencement of work shall be construed as complete acceptance of existing conditions and preparatory work.

E. Owner assumes no responsibility for any understanding or representation made during or prior to the negotiation and execution of this Contract unless such understanding or representations are expressly stated in the Contract, and the Contract expressly provides that the responsibility, therefore, is assumed by the Owner.

1.10 DISCREPANCIES IN DOCUMENTS

A. Where Drawings or Specifications conflict or are unclear, advise the Consultant in writing before award of Contract. Otherwise, Consultant’s interpretation of the Contract documents shall be final, and no additional compensation shall be permitted due to discrepancies or ambiguousness thus resolved.

B. Where Drawings or Specifications do not coincide with manufacturer’s recommendations, or with applicable codes and standards, alert the Consultant in writing before installation. Otherwise, make changes in installed work as the Consultant requires within Contract Price.

C. If the required material, installation, or work can be interpreted differently from drawing to drawing, or between drawings and specification, this contractor shall provide material, installation, or work which is of higher standard.

D. It is the requirement of these documents to have contractor provide systems and components that are fully complete and fully operational and fully suitable for intended use. There may be situations in the documents where insufficient information exists to precisely describe a certain component or subsystem, or the routing of the component or its coordination with other building elements. In cases such as this, where the contractor has failed to notify the Consultant of the situation in accordance with paragraph (A) above, the contractor shall provide specific component or subsystem with all parts necessary for the intended use, fully complete and operational, and installed in workmanlike manner either concealed or exposed per the design intent.

E. In cases covered by paragraph (D) above, where the contractor believes he needs the engineering guidance, he shall submit a sketch identifying his proposed solution and the Consultant shall review, note if necessary, and approve the sketch.

1.11 MODIFICATION IN LAYOUT

A. Electrical, Mechanical, Plumbing and Fire Protection Drawings are diagrammatic. They indicate general arrangements of mechanical and electrical systems and other work. They do not show all offsets required for coordination nor do they show exact routings and locations needed to coordinate with structure and other trades to meet the Consultant's requirements

B. In order to obtain the Architect's desired aesthetics in spaces used by building occupants; prior to installation of visible materials, finishes and equipment (including access panels), review Consultant's Drawings for desired locations and where not definitely indicated, request information from the Architect/Consultant.

C. Check Contract Drawings, as well as Shop Drawings, of all subcontractors to verify and coordinate spaces in which work of this section will be installed

D. Maintain maximum headroom at all locations. All conduit, piping, duct and associated components to be as tight to underside of structure as possible.

E. Make reasonable modifications in layout and components to prevent conflict with work of other trades and to coordinate according to Paragraphs A,B,C,and D above. Systems shall be run in an organized and rectilinear fashion.

F. Where conflicts or potential conflict exists and engineering guidance is desired, submit sketch of proposed resolution to the Consultant for review and approval

1.12 MEASUREMENTS

A. Contractor shall base all his measurements, both horizontal and vertical from established benchmark. All work shall agree with these established lines and levels. He shall verify all measurements at site; and check the correctness of same as related to the work.

1.13 MATERIALS AND WORKMANSHIP

A. Materials shall be new, meet detailed requirements of the Contract Documents and be identifiable as being specified or substitute products.

B. Materials which do not conform to the requirements of the Contract Documents, are not equal to approved samples or are unsatisfactory or unsuited to the purpose for which they are intended, will be rejected.

C. All work shall be performed in the best and most workmanlike manner by tradesmen skilled in their respective trades and properly licensed.

D. All equipment shall be installed in accordance with the recommendation of the manufacturer.

E. Defective work, whether the result of poor workmanship, use of defective materials, damage through carelessness, or other cause shall be removed within ten (10) days after written notice is given by the Owner's Representative and the work shall be re-executed by the Contractor. The fact that the Owner's Representative may have previously overlooked such defective work shall not constitute total or partial acceptance of it.

F. In no case shall a Bidder base his bid on a class of material or workmanship less than that required by the contract documents nor the governing codes and ordinances.

1.14 CHECKING AND TESTING EQUIPMENT BY CONTRACTORS AND MANUFACTURER'S REPRESENTATIVE

A. All equipment shall be installed in strict accordance with manufacturer's instructions. During construction request supervisory assistance from equipment manufacturer's representatives so the equipment will be correctly installed. After installation, request the Owner's Representative to inspect and see the equipment is in proper working order.

B. Manufacturer's representative shall review the overall system design relative to the proper application of his equipment in the particular system. He shall note conduit, wiring, control, location, and other relevant relationships, and furnish appurtenances necessary for satisfactory operation.

C. Before final payment is issued the following shall be complete:

D. The Contractor's representative shall submit to the CM a signed statement certifying:

1. The equipment is properly installed and ready for operation
2. The owners maintenance representatives have been thoroughly trained
3. Maintenance and operation manuals issued and accepted by the Owner's Representative.

1.15 PROJECT COMMUNICATION

A. Communication and Submittals:

B. The specification references communication and submittal of information and documents by the Contractor to the Engineers of Record and CM or visa versa. In all cases such communication shall be submitted to the CM who will review it before forwarding to the relevant party for review and response.

C. If the information provided is not in conformance with the specification the CM shall return it to the relevant Contractor for re-submission.

D. The time taken for this process shall be factored into all work schedules and submissions.

1.16 RFI'S

A. If the RFI is a request to resolve a conflict or an un-clarity, or a request for additional detail, Contractor's RFI shall include a sketch or equivalent description of Contractor's proposed solution, in accordance with paragraph 1.10(E) above.

1.17 SUBMITTALS

A. This paragraph supplements Division 1.

B. Definitions:

1. Shop Drawings are information prepared by the Contractor to illustrate portions of the work in more detail than shown in Contract Documents.
2. Coordination Drawings are detailed, large scale layout Shop Drawings showing Electrical, Mechanical, Plumbing and Fire protection work superimposed in order to identify conflicts and ensure inter-coordination of Electrical, Mechanical, Plumbing, Fire Protection, Structural and other work.

C. Submittal Cover Sheet

1. Shop drawing submittal for each product shall include the copy of following cover sheet completely filled out. Incomplete or incorrect cover sheet submittal shall constitute reason for rejection.
2. Shop drawings shall be submitted according to specification section with a separate cover sheet completed for each product, rather than one cover sheet for multiple products, whether or not supplied by one manufacturer or vendor.
3. In order to maintain the shop drawing review schedule described hereafter, it is important that all submittals include a completed submittal cover sheet for each type of equipment submitted. This requirement will be enforced by the engineer.

SHOP DRAWING COVER SHEET			
PROJECT CONTRACTOR			
DIVISION NO:		SECTION NO:	
DESCRIPTION:			
CONTRACT DRAWING REFERENCE NO:			
EQUIPMENT TAG:			
SUBMISSION (CIRCLE ONE): I II III IV V			
SUBMISSION (CIRCLE ONE): **I II III IV**			
DATE:			
INFORMATION AND CHECKLIST		REPLY	COMMENTS
a.	Contractor's Log # ID		
b.	Name, address, and phone number of supplier		
c.	Are all specified or scheduled items included and exactly match scheduled/specified items.		d. Yes No
e.	Is this item a substitution?		f. Ye

			s N o
	g. Are deviations clearly identified?		h. Y e s N o
	i. Does this equipment fit space shown on construction documents, coordination drawings, and actual field conditions?		j. Y e s N o
	k. Has support, erection, weights, and installation been coordinated with all trades?		l. Y e s N o
	m. Does the proposed installation void warranties and/or violate UL or code requirements?		n. Y e s N o
	o. Does this material/equipment add expense to any other trade or project costs?		p. Y e s N o
	q. Does equipment require interface with other trades? Lists divisions and specifics requiring coordination?		r. Y e s N o
	s. Is control interface coordinated?		t. Y e s N o
	u. List electrical characteristics (V/Ph/A)		v. Y e s N o

D. Submittals procedure and format:

1. Identify each item by manufacturer, brand, trade name, number, size, rating, or whatever other data is necessary to properly identify and check materials and equipment.
2. Identify each submittal item by reference to Specification Section paragraph in which item is specified, or Drawing and Detail number, identify deviations, if any.
3. Organize submittals in same sequence as they appear in Specification Sections, articles or paragraphs.

4. Shop Drawings shall show physical arrangement, construction details and finishes:
5. Drawings shall be drawn to scale and dimensioned where applicable.
6. Catalog cuts and published material shall be included to supplement scale drawings.
7. Internal wiring diagrams of equipment shall show wiring as actually furnished for this project, with all optional items clearly identified as included or excluded. Clearly identify external wiring connections. Identify and obliterate superfluous material.
8. Submittal literature, drawings and wiring diagrams shall be specifically applicable to this Project and shall not contain extraneous material or optional choices. Clearly mark literature to indicate the proposed item. Submittals shall include, but not be limited to those items listed in individual Sections.
9. Include all physical and performance data, including materials, manufacturer's names, model numbers, weights, sizes, capacities, performance curves, finishes, colors, accessories, installation instructions, and all other data required to completely describe equipment and to indicate complete compliance with Specifications and Drawings.
10. Include with complete submittals above, complete, large scale, dimensioned Shop Drawings, certified by manufacturer, of all major equipment.
11. Time Schedules for Submission and Ordering: The Contractor shall prepare, review and coordinate his schedule of submissions carefully, determining the necessary lead time for preparing, submitting, checking, ordering and delivery of all materials and equipment for timely arrival. The Contractor shall be responsible for conformance with the overall construction schedule.
12. Submittals shall be reviewed for general compliance with Specifications only. The Contractor shall be responsible for deviations from the Drawings or Specifications and for errors or omissions of any sort in submittals.
13. The Contractor shall add and sign the following paragraph on all equipment and materials submitted for review:
14. "It is hereby certified that the equipment, material shown and marked in this submittal is that proposed to be incorporated into the project; is in compliance with the Contract Drawings and Specifications and can be installed in the allocated spaces."
15. Failure to add the above written statement for compliance shall result in return of submittals to be reviewed.
16. The Contractor shall verify dimensions of equipment and be satisfied per Applicable Code Requirements for fit prior to submitting Shop Drawings for approval.
17. Where current limiting devices are specified, submit technical data to substantiate adequate protection of equipment cascaded downstream. Submittals shall not be reviewed unless supporting calculations and data are submitted therewith.
18. For any material specified to meet Underwriters' Laboratories, Inc. (UL) or trade standards, furnish the manufacturer's or vendor's certification that the material furnished for the work does in fact equal or exceed such Specifications.
19. Submit on all materials and equipment even if they are as specified or shown on the Drawings.
20. Equipment Floor Plans: After approval of material is secured, prepare a floor plan of each electrical equipment closet enclosures and room drawn to, scale of 1/2 inch equals 1 foot, and submit for approval in the same manner as for Shop Drawings. The layout drawings shall be to exact scale, and indicate location of all electrical equipment.
21. Resubmittals shall include written response to each item in review of previous submittal.
22. Special Submissions:
23. Test reports for the following:
24. Ground fault devices, including ground fault interrupter (GFI) receptacles.
25. Megger Readings: Ground system, motors, feeders and switchgear.
26. Voltage Readings: Distribution, service and motors.
27. Emergency lighting systems.
28. Fire Alarm system.
29. Acceptance testing per NETA Specifications for all power system equipment. Include manufacturer’s testing standards used to verify the test results.

30. Field inspection reports by manufacturer's engineer confirming that the respective equipment is installed correctly, and it meets the manufacturer's requirements.
31. Report indicating compliance with Contractor furnished "Overcurrent Protective Device Short-Circuit Study".
32. Report indicating compliance with Contractor furnished "Overcurrent Protective Device Coordination Study".
33. Report indicating compliance with Contractor furnished "Overcurrent Protective Device Arc-Flash Study".
34. 1/2" scale equipment layout for each electrical, elevator, and mechanical equipment room, indicating all working clearance.

E. Acceptable Manufacturers: The Consultant's mechanical/electrical design for each product is based on the single manufacturer listed in the schedule or shown on the drawings. In Part 2 of the specifications certain Alternate Manufacturers are listed as being acceptable. These are acceptable only if, as a minimum, they:

1. Meet all performance criteria listed in the schedules and outlined in the specifications. For example, to be acceptable, an air handling unit must deliver equal CFM against equal external static pressure using equal or less horsepower, equal or better coil thermal performance, equal or better acoustic performance as the air handler listed in schedules.
2. Have identical operating characteristics to those called for in the specifications. For example, a two stroke diesel generator will not be acceptable if a four stroke is specified.
3. Fit within the available space it was designed for, including space for maintenance and component removal, with no modification to either space or product. Clearances to walls, ceilings and other equipment will be least equal to those shown on the design drawings. The fact that a manufacturer's name appears as acceptable shall not be taken to mean that the Consultants has determined that the manufacturer's products will fit within the available space. This determination is solely the responsibility of the contractor.
4. Products must adhere to all Consultant's considerations including, but not limited to: being of same color as the product scheduled or specified, fitting within Consultant's enclosures and details, and for diffusers, lighting and plumbing fixtures – being the same size and physical appearance as scheduled or specified products.
5. The proposed substitution shall meet performance and quality of scheduled equipment, whether it requires additional accessories or not.
6. There is no increase in Contract Sum and this Contractor shall pay for any additional work required by other trades as a result of the substitution.
7. Submit all equipment sound power and pressure level for review and compliance.

F. Required Use of Acceptable Manufacturers on his Project: Substitution of products other than those of the Acceptable Manufacturers specified herein shall not be made. Only the specified items or the comparable product by one of the specified Alternate Manufacturers shall be submitted. Products by other manufacturers shall not be used on this project.

G. Deviations:

1. Concerning deviations other than substitutions, proposed deviations from Contract Documents shall be requested individually in writing whether deviations result from field conditions, standard shop practice or other cause. Submit letter with transmittal of shop drawings, which flags deviation to the attention of the Consultants.

2. Without letters flagging the deviation to the Consultants, it is possible that the Consultants may not notice such deviation or may not realize its ramifications. Therefore, if such letters are not submitted to the Consultants, the contractor shall hold the Consultants and his consultants harmless for any adverse consequences resulting from the deviations being implemented. This shall apply regardless of whether the Consultants has reviewed or approved shop drawings containing the deviation, and will be strictly enforced.
3. Approval of proposed deviations, if any, will be made at discretion of Consultants.
4. Any of the approved deviations shall be deemed acceptable to this Contractor with no change in contract sum, unless the Consultant also receives a written notice to the contrary.

H. Submittal Notations: Submittals will be returned from the Consultants marked as illustrated below:

1. REVIEWED: “Reviewed and found generally acceptable. Minor deviations may be noted. No further submittal required if notations are complied with.”
2. REVIEWED, DEVIATIONS NOTED; REVISE AND RESUBMIT: “Submittal contains deviations which must be corrected and confirmed by a new submittal.”
3. REJECTED: “Submittal is incorrect to such an extent that the material is unacceptable, or in incomplete to such an extent that a review cannot be made. Resubmit in accordance with requirements of the Contract Documents.”

I. Responsibility:

1. Intent of Submittal review is to check for capacity, rating, and certain construction features. Contractor shall ensure that the work meets the requirements of Contract Documents regarding information that pertains to fabrication processes or means, methods, techniques, sequences and procedures of construction; and for coordination of work of this or other Sections. Work shall comply with submittals marked “REVIEWED” to the extent they agree with the Contract Documents. Submittal review shall not diminish responsibility under this Contract for dimensional coordination, quantities, installation, wiring, supports and access for service, nor shop drawing errors or deviations from requirements of Contract Documents. The Consultant’s noting of some errors while overlooking the others will not excuse the contractor from proceeding in error. Contract Documents are not limited, waived nor superseded in any way by review.
2. INFORM SUBCONTRACTORS, MANUFACTURERS, SUPPLIERS, ETC. OF SCOPE AND LIMITED NATURE OF REVIEW PROCESS AND ENFORCE COMPLIANCE WITH CONTRACT DOCUMENTS.

J. Schedule: Incorporate shop drawing review period into construction schedule so that Work is not delayed. Contractor shall assume full responsibility for delays caused by not incorporating the following review time requirements into his project schedule. Working days listed reference the time in Engineer’s office. It does not include transmittal time or review time of Contractor or the Consultant. Allow at least 10 working days, exclusive of transmittal time, for review each time shop drawing is submitted or resubmitted with the exception that 20 working days, exclusive of transmittal time, are required for the following:

1. Coordination Drawings: If more than five shop drawings of a single trade are received in one calendar week.

1.18 List of Proposed Equipment and Materials:

A. Within four weeks of Award of Contract and before ordering materials or equipment, submit complete list of materials and equipment and indicate manufacturer's name, addresses and telephone numbers. No consideration will be given to partial lists submitted out of sequence.

B. If the List of Materials and Equipment is not received within the prescribed time limit, provide the first-named manufacturer for all material and equipment on this project.

1.19 EQUIPMENT SUPPLIER'S INSPECTION.

A. The following equipment shall not be placed in operation until a competent installation and service representative of the manufacturer has inspected the installation and certified that the equipment is properly installed, adjusted and lubricated; that preliminary operating instructions have been given; and that the equipment is ready for operation:

1. Generator
2. Automatic Transfer Switch
3. Fire Seal Systems
4. Seismic Restraints and Equipment Bracing

B. Contractor shall arrange for and obtain supplier's on-site inspection(s) at proper time(s) to assure each phase of equipment installation and/or connection is in accordance with the manufacturer's instructions.

C. Submit copies of start-up reports to the Engineer and include copies IN THE Project Close-Out and Owner's Operation and Maintenance Manuals.

D. Refer to each Section for specific equipment inspection requirements and procedure.

1.20 OPERATING AND MAINTENANCE MANUALS

A. Obtain at time of purchase of equipment, three copies of operation and maintenance manuals for all items. Assemble literature in coordinated "D" ring notebooks. All information shall also be provided in electronic PDF format. Divide the manuals into three sections or books as follows:

B. System General Description and Information. Section shall include a general description of the systems used and contain names and addresses of manufacturers and local representatives who stock or furnish or repair parts for items or equipment. List of all major equipment as installed and include model number, capacities, nameplate data and manufacturer's location and purchase order information. Include in the manuals, parts catalogs for each item of equipment furnished with the components identified by number for replacement ordering. This section shall also include:

1. Letters from manufacturers certifying their supervision of equipment installation and startup procedures as required.
2. Factory certification test certificates.
3. Equipment test certificates.

C. Operation, Start-up and Shutdown Procedures. Section shall include directions for and sequence of operation for each item of the Mechanical and Electrical systems; e.g., UPS generator, etc. Include detailed approved electrical diagrams for each electrical system.

D. Provide a step-by-step write-up and video of the operation, start-up and shut down procedures for all major equipment.

E. Problems, Solutions and Troubleshooting. Section shall include detailed procedures to be followed in case of equipment or system malfunctions. Include manufacturer's printed troubleshooting procedures into the operating manual for reference.

F. Preventative Maintenance. Section shall include preventative maintenance requirements and schedule for each piece of equipment.

G. Furnish three copies of manuals to the Consultant for approval and distribution to Owner. Deliver manuals no less than 30 days prior to project close-out or 10 days prior to commissioning whichever is sooner.

1.21 RECORD DOCUMENTS (AS-BUILTS)

A. As work progresses and for duration of Contract, maintain current complete and separate sets of prints of Contract drawings at job site. Record work completed and all changes from original Contract Drawings clearly and accurately including work installed as a modification or addition to original design. Include actual location of existing utilities if they differ from design documents.

B. Underground utility services, both inside and outside of buildings, shall be dimensioned from permanent structures or benchmark. Utility services outside of buildings shall also show depth of burial with reference to the finished ground floor elevation.

C. Drawings shall show record condition of details, sections, riser diagrams, control changes and correction to schedules. Schedules shall show actual manufacturer and make and model numbers of final equipment installation. All elements shall be dimensioned from grid lines or benchmarks and all elevations shall be noted. Construction notes (such as component numbers, conflict notes, etc.) shall be removed and the drawings shall clearly be noted in the title block as being as-built drawings.

D. At the completion of the project, prepare a complete set of record drawings, showing all systems actually installed, as well as electronic files on latest CAD version.

E. The design tracings will be made available for Contractor’s copying, at his expense, into reproducible to serve as background drawings. The quantity of design tracings, which are made available shall in no way be interpreted as setting a limit to the number of drawings necessary to show required information. Contractor’s professional draftsperson shall transfer changes to record files and then submit the electronic files and three sets of prints to the Consultant for comments as to compliance with this section.

F. The record set reproducible, as corrected and recorded by the Contractor, shall be submitted to the Owner’s Representative for approval prior to authorization for final payment. Record drawings shall be certified as to their correctness by the signature of the Contractor, and shall be stamped or otherwise identified as record drawings. THE CONSULTANT WILL NOT CERTIFY THE ACCURACY OF THE RECORD DRAWINGS – THIS IS THE SOLE RESPONSIBILITY OF THE CONTRACTOR.

G. Each trade shall submit a record set for approval by the building department in a form acceptable to the department, when required by the jurisdiction. Such drawing format size changes, and supplemental information required for the submittal are the requirement of the contractor.

1.22 COOPERATION BETWEEN TRADES

A. Cooperate with all other Divisions performing work on this project as necessary to achieve a complete neatly fitted installation for each condition. Consult the Drawings and Specifications to determine nature and extent of work specified in other Divisions that adjoins or attaches to the work of this Division. Confer with other Divisions at the site to coordinate this work with theirs in view of job conditions to the end that interferences may be eliminated and that maximum head room and clearance may be obtained. In the event that interferences develop, the Owner's Representative's decision will be final as to which Division shall relocate its work, and no additional compensation will be allowed for the moving of piping, ductwork, conduit, or equipment, to clear such interferences. Provide templates, information, and instructions to other divisions to properly locate holes and openings to be cut or provided

1.23 HOIST, RIGGING, TRANSPORTATION AND SCAFFOLDING

A. Provide all scaffolding, staging, cribbing, tackle hoist and rigging necessary for placing all materials and equipment in their proper places in the Project. All temporary work shall be removed from the premises when its use is no longer required.

1.24 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Store electrical equipment indoors in clean, dry space with uniform temperature to prevent condensation. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. Do not install indoor equipment until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above equipment is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

C. Identify materials and equipment delivered to Site to permit check against approved materials list, reviewed Shop Drawings.

D. Cap all openings in conduit daily to protect against entry by foreign matter.

E. Protect premises and Work of other Divisions from damage arising out of installation of Work of this Division.

F. Perform Work in manner precluding unnecessary safety and hazard.

G. Protect from loss or damage. Replace lost or damaged materials and equipment with new at no increase in Contract Sum. Protect from damage, water, dust, etc., material, equipment and apparatus provided under this Division, both in storage and installed, until Notice of Completion has been filed. Provide temporary storage facilities for material and equipment. Material, equipment or apparatus damaged because of improper storage or protection will be rejected. Remove from Site and provide new, duplicate material, equipment or apparatus in replacement of that rejected.

H. All stock piled conduit shall be placed on dunnage, and protected from weather and from entry of foreign material. All stored materials and equipment shall be carefully inspected prior to installation and replaced with new material or equipment if found to be damaged, corroded, etc.

1.25 GUARANTEE AND 24 HOUR SERVICE

A. Guarantee the Work of this section for one year following the date of Substantial Completion or successful system performance whichever requires later. The warranty may also commence if a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization of the Owner. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the owner.

B. The guarantee shall repair or replace defective materials, equipment, workmanship and installation that develop within this period, promptly and to the Consultant’s satisfaction and correct damage caused in making necessary repairs and replacements under guarantee within Contract Price.

C. In addition to guarantee requirements of Division 1 and of Paragraph A above, obtain written equipment and material warranties offered in manufacturer’s published data without exclusion or limitation, in Owner’s name.

D. Replace material and equipment that require excessive service during guarantee period as defined and as directed by the Consultant.

E. Provide 24 hour service beginning on the date of substantial completion and lasting until the termination of guarantee period. Service shall be at no cost to Owner. Service can be provided by this Contractor or a separate service organization. Choice of service organization shall be subject to the Consultant and Owner approval. Submit name and phone number that will be answered on a 24 hour basis each day of the week, for the duration of the service.

F. Submit copies of equipment and material warranties to Consultants before final payment.

G. At end of guarantee period, transfer manufacturer’s equipment and warranties still in force to Owner.

H. This paragraph shall not be interpreted to limit Owner’s rights under applicable codes and laws under this Contract.

I. Part 2 Paragraphs of the Specification sections may specify warranty requirements that may exceed those of this Paragraph.

J. Use of systems provided under this Section for temporary services and facilities shall not constitute Final Acceptance of work nor beneficial use by Owner, and shall not institute guarantee period.

K. Provide manufacturer's engineering and technical staff at site to analyze and rectify problems that develop during guarantee period immediately. If problems cannot be rectified immediately to Owner's satisfaction, advise the Consultant in writing, describe efforts to rectify situation, and provide analysis of cause of problem. Consultants will suggest course of action.

1.26 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

PART 2 PRODUCTS

2.1 GENERAL

A. Equipment and materials shall be as described in the respective Sections of Division 21, 22,23 and Division 26 and as shown.

2.2 MATERIALS

A. Equipment specified by manufacturer's number shall include all accessories, controls, etc., listed in catalog as standard with equipment. Furnish optional or additional accessories as specified. And or/as required to provide a fully operational installation.

B. Equipment, material damaged during transportation, installation, operation is considered as totally damaged. Replace with new. Payment for this equipment shall not be approved. Variance from this permitted only with written acceptance.

C. All items of materials in each category of equipment shall be of one manufacturer.

D. Material and Equipment General Requirements:

1. All equipment and components shall be New.
2. Testing agency labeled or with other identification wherever standards have been established.
3. Owner's Representative reserves right to reject items not in accordance with Specification either before or after installation.
4. Comprised to render complete and operable systems; provide additional items needed to complete installation to realized design.
5. Compatible with space allocated. Modifications necessary to adjust items to space limitations at Contractor's expense.
6. Installed fully operating and without objectionable noise or vibration.

PART 3 EXECUTION

3.1 COMMISSIONING OF EQUIPMENT AND SYSTEMS

A. General

1. Completion of startup and commissioning shall be accomplished as a prerequisite for substantial completion and shall be completed for each phase of construction.
2. Operate and maintain systems and equipment until final acceptance by Owner.
3. All guarantees and warranties shall not begin until final acceptance of the systems and equipment by the Owner. Acceptance requires, at a minimum complete systems and commissioning.
4. The Owner maintains the right to have access to the entire project site to develop his own operational procedures.

B. Comprehensive Work Plan and Reporting

1. Provide detailed, methodical, scheduled, start up and commissioning procedures and execution of same and every system and piece of equipment provided.
2. Attend start up and commissioning meetings on a regular basis, as directed by the General Contractor or Construction Manager.
3. Develop and provide a written work plan with detailed procedures for this work and submit, using shop drawing submittal procedure, within 6 weeks of the contract award. The work plan shall include provisions for an integrated start up plan and schedule. The plan and schedule shall identify tasks, start and completion dates, critical path items, interface requirements with other trades and major equipment start up, as minimum requirements of the plan. The plan and schedule shall clearly identify work in each construction phase, as well.
4. The purpose of this work plan is to provide for smooth, quick, and efficient start up and commissioning of systems and equipment and for a smooth transition to turn the complete, correctly operating building over to the Owner, at each phase of construction.
5. The Owner and the Consultant will have input to and be part of approval process for startup and commissioning plan.
6. Develop and submit for approval a specific start up, check out and sign off form for every piece of major equipment.
7. Develop and submit for approval a specific start up, check out and sign off form for every piece of major system.
8. Systems shall be operated under actual or simulated full load conditions. Identify the operating conditions in the work plan.
9. Work plan shall incorporate the below specified “Demonstration of Successful Operation”
10. The Consultant/Owner may check the completed and commissioned installation either sequentially as different parts are completed, and/or when the entire installation is complete, at sole option of the Consultant/Owner.
11. Each contractor shall arrange that an officer of his contracting company shall certify that each and every system has been tested. At the conclusion of the tests, this contractor shall submit a letter and enclosed commissioning forms signed by the officer stating:
12. That he/she is the officer of the company.
13. That he/she certifies that the specified testing of the systems has been performed by the company (give the name and dates of system testing).
14. The results of testing as compared to specified performance, listing the name, title, and company affiliation of all those witnessing and performing these tests.

C. Commissioning

1. Commission equipment and systems in accordance with the approved work plan, completing the startup, check out and sign off forms for each piece of equipment and each system.
2. Provide qualified personnel, equipment, apparatus and services for startup and testing of equipment and systems, to obtain the performance shown in schedules, as specified or on commissioning forms, and as required by codes, standards, regulations and authorities having jurisdiction including Municipal Inspectors, Owners and Consultants.
3. Start up and testing procedures as may be outlined in various mechanical and electrical sections of the specifications are the minimum effort required for the project. Contractor shall use any additional procedures he feels will be necessary to properly start up and test the systems and equipment actually installed on the job at no additional cost to the Owner.
4. Provide capacity and performance of equipment by field testing. Install thermowells and gauge connections and, at no additional cost to Owner, equipment and instruments required for testing.
5. Qualified representative of equipment manufacturer shall be present at test.
6. For each piece of equipment, copy nameplate data and include with the letter and start up, check out and sign off forms referred to above.
7. Do not cover or conceal work before testing and inspection and obtaining approval.
8. Leaks, damage and defects discovered or resulting from startup and testing shall be repaired or replaced by this contract to like-new condition with acceptable materials. Tests shall be continued until system operates without adjustments or repairs.

D. Demonstration of Successful Operation: After all components and every system has been completely commissioned, provide a two week, 24 hour per day fully functional automatic operation period of all systems simultaneously. This shall be successfully concluded before systems are accepted by the Owner.

3.2 SPECIAL RESPONSIBILITIES:

A. Cooperate and coordinate with work of other Sections in executing work of this Section.

1. Perform work such that progress of entire project including work of other Sections shall not be interfered with or delayed.
2. Provide information as requested on items furnished under this Section which shall be installed under other Sections.
3. Obtain detailed installation information from manufacturers of equipment provided under this section.
4. Obtain final roughing dimensions or other information needed for complete installation of items furnished under other Sections or by Owner.
5. Keep fully informed as to shape, size and position of openings required for material or equipment to be provided under this and other Sections. Give full information so that openings required by work of this Section may be coordinated with other work and other openings and may be provided for in advance. In case of failure to provide sufficient information on proper time, provide cutting and patching or have same done, at own expense and to full satisfaction of Consultants.
6. Provide information as requested as to sizes, number and locations of pads necessary for floor mounted equipment provided under this Section.

7. Notify Consultants of location and extent of existing piping, conduit, ductwork and equipment that interferes with new construction. In coordination with and with approval of Consultants, relocate piping, ductwork and equipment to permit new work to be provided as required by Contract Documents. Remove non-functioning and abandoned piping, ductwork and equipment as directed by Consultants. Dispose of or store items as requested by Consultants.

B. Installation Only Items

1. Where this contractor is required to install items which it does not purchase, it shall coordinate delivery and be responsible for their unloading from delivery vehicles and for their safe handling and field storage up to time of installation. This trade shall be responsible for:
2. Any necessary field assembly and internal connections, as well as mounting in place of the items, including the purchase and installation of all dunnage supporting members and fastenings necessary to adapt to Consultant's and structural conditions.
3. Their connection to building systems including the purchase and installation of all terminating fittings necessary to adapt and connect them to the building systems.
4. This contractor shall carefully examine such items upon delivery. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of work of this contractor will be considered only if presented in writing within one week of their date of delivery. Unless such claims have been submitted this contractor shall be fully responsible for the complete reconditioning or replacement of the damaged items.

C. Maintenance of equipment and systems: Maintain equipment and systems until Final Acceptance. Ensure adequate protection of equipment and material during delivery, storage, installation and shutdown and during delays pending final test of systems and equipment because of seasonal conditions.

D. Use of premises: Use of premises shall be restricted as directed by the Consultant and as required below:

1. Remove and dispose of dirt and debris, and keep premises clean. During progress of work, remove equipment and unused material. Put building and premises in neat and clean condition, and do cleaning and washing required to provide acceptable appearance and operation of equipment, to satisfaction of the Consultant.
2. Store materials in a manner that will maintain an orderly clean appearance. If stored on-site in open or unprotected areas, all equipment and material shall be kept off the ground by means of pallets of racks and covered with tarpaulins.
3. Do not interfere with function of existing sewers and water and gas mains, electrical or mechanical systems and services. Extreme care shall be observed to prevent debris from entering pipe, ductwork and equipment. Confer with the Consultant as to the disruption of services or other utilities due to testing, connection of new work to existing. Interruption of services shall be performed at time of day or night deemed by Owner to provide minimal interference with normal operation. Obtain Owner's approval of the method proposed for minimizing service interruption.

E. Surveys and Measurements:

1. Base measurements, both horizontal and vertical, on reference points established by Contractor and be responsible for correct laying out of work.
2. In event of discrepancy between actual measurements and those indicated, notify the Consultant in writing and do not proceed with work until written instructions have been issued by the Consultant.

F. Fireproofing:

1. Clip, hangers, clamps, supports and other attachments to surfaces to be fireproofed shall be installed, insofar as possible prior to start of spray fiber work.
2. Conduit and other items which would interfere with proper application of fireproofing shall be installed after completion of spray fiber work.
3. Patching and repairing of fireproofing due to cutting or damaging to fireproofing during course of work specified under this section shall be shall be performed by installer of fireproofing and paid for by the trade responsible for damage and shall not constitute grounds for an extra to Owner.

G. Temporary Utilities:

1. Refer to Division 1 regarding requirements.
2. Furnish temporary equipment, and wiring, as needed during the construction phase. Remove temporary items after use.

3.3 MATERIAL AND WORKMANSHIP

A. Work shall be neat and rectilinear. Install material and equipment to comply with manufacturers. Recommended Requirements. Rough Work will be rejected. Work shall be properly and effectively protected, and conduit openings shall be temporarily closed to prevent obstruction and damage before completion.

B. Except as specified otherwise, material and equipment shall be new. Provide supplies, appliances and connections necessary for complete and operational installation. Provide components required or recommended by OSHA and applicable NFPA documents.

C. Finish of materials, components and equipment shall be as approved by the Consultant and shall be resistant to corrosion and weather as necessary.

D. Owner will not be responsible for material and equipment before testing, commissioning, and acceptance.

3.4 CONTINUITY OF SERVICES

A. Schedule interruptions in advance, according to Owner’s instructions. Submit, in writing, with request for interruption, methods proposed to minimize length of interruption.

B. Interruptions shall be scheduled at such times of day and work so that they have minimal impact to Owner’s operations.

C. Subcontractor shall coordinate any shutdowns of existing systems as follows:

1. Give proper notice to Owner when making shutdowns; a minimum of fourteen full days are required.
2. Minimize shutdowns of any system.
3. Provide temporary services where required and perform shutdown and tie-ins at a time convenient to Owner.
4. Subcontractor shall be responsible for completing and filing Owner’s shutdown notice questionnaire.
5. Perform required survey and inspection work required by the notice for shutdown.

D. Include premium time work associated with interruption of services and/or shutdown as necessary to avoid disruption to Owner's operations.

3.5 ANCHORS AND INSERTS:

A. Inserts shall be iron or steel of type to receive machine bolt head or nut after installation. Insert shall permit adjustment of bolt in one horizontal direction and shall develop strength of bolt when installed in properly cured concrete.

B. Provide anchors as necessary for attachment of equipment support and hangers.

3.6 CORE DRILLING

A. Core drilling is to be avoided.

B. Set sleeves prior to installation of structure for passage of conduits, etc.

C. Where core drilling is unavoidable, locate all required openings prior to coring, perform infrared scan and submit to the Consultant for review.

D. Coordinate openings with General Contractor/Construction Manager and all other trades.

E. Core drilling is to be provided by the Contractor for General Construction and not by the M/E subcontractors.

F. Do not disturb existing systems.

G. Thoroughly investigate existing conditions in vicinity of required opening prior to coring.

3.7 CUTTING AND PATCHING:

A. Complete cutting and patching in accordance with Division 1, Cutting and Patching Article, and as follows.

B. Provide all sleeves, core drilling, carpentry, cutting and patching required for proper installation of material and equipment specified in this Division.

C. Do not cut or drill structural members without written approval of Owner's Representative and structural engineer.

D. No cutting or patching should be done without first receiving the Consultant's and Structural Engineer's written approval.

E. Any damage caused by cutting and patching shall be restored to the original condition as required by the Consultant.

3.8 VIBRATION CONTROL:

A. Coordinate with Division 1.

B. Design criteria for all the Work of Division 26 shall be as specified in 260548.

3.9 WATERPROOF CONSTRUCTION:

A. Maintain waterproof integrity of penetrations of materials intended to be waterproof. Provide flashing at exterior wall and roof penetrations. Caulk watertight penetrations of foundation walls and floors. Provide membrane clamps at penetrations of waterproof membranes.

B. Provide galvanized sheet metal weather protection canopies, hoods or enclosures over all out-of-doors equipment, the operation or maintenance of which would be impaired by rainwater. This requirement applies to damper operators and bearing, damper motors, controls, and instruments. See other paragraphs in this Division for application of this requirement to panels, motors, and devices.

3.10 RESTORATION OF DAMAGE:

A. Repair or replace, as directed by the Consultant and/or Owner’s Representative, materials and parts of premises which become damaged as result of installation of Work of this Division. Remove replaced parts from premises.

3.11 ROOF OPENINGS AND CURBS

A. Roof openings where required shall be coordinated with the other affected trades and all flashing and patching shall be as per details indicated on the Consultant’s plans.

3.12 TOOLS AND EQUIPMENT

A. Furnish all tools and equipment necessary for the proper installation, protection and upkeep of the Work.

3.13 ADJUSTMENTS

A. Preliminary Operation: Operate any portion of installation for Owner's convenience if so requested by Construction Manager. Such operation does not constitute acceptance of Work as complete. Cost of utilities, such as gas and electrical power, will be borne by Owner if Owner requests operation.

B. Start-up Service: Prior to startup, ensure that systems are ready for their intended use.

C. Start and operate all systems. Provide services of factory trained technicians for startup of major equipment and systems.

D. Adjusting:

1. Adjust all equipment and system components as shown or as otherwise required to result in intended system operation.
2. Thereafter, as a result of system operation or as directed by Owner’s Representative, make readjustments as necessary to refine performance and to effect complete system "tune-up".

3. After completion of testing and adjustment, operate the different systems and equipment under normal working conditions for 72 hours continuously and show specified performance.
4. If, in the opinion of the Consultant, performance of equipment or systems is not in accordance with specifications or submitted data, alter or replace equipment at no increase in Contract Sum. The Contractor, at his option, may order tests from an independent approved laboratory to prove compliance. All such tests shall be at no increase in Contract Sum. Repeat process as often as required. If the reason for unsatisfactory operation is design errors all additional cost for corrective measures will be reimbursed to the contractor.
5. At completion of Work, provide written certification that all systems are functioning properly without defects.

E. Noise:

1. Cooperate in reducing any objectionable noise or vibration caused by electrical systems to the extent of adjustments to specified and installed equipment and appurtenances.
2. Cooperate in adjustment of mechanical systems and terminal devices, as directed by Owner's Representative, to obtain specified acoustic properties.
3. Completely correct noise problems caused by failure to make installation in accordance with Contract Documents, including labor and materials required as a result of such failure, at no increase in Contract Sum. Includes refinish walls, floors etc.

3.14 INSTALLATION

A. Comply with NECA 1.

B. Coordinate connection of electrical service with utility provider. Comply with utility provider requirements and local codes and regulations.

C. Coordinate connection of branch circuits and feeders to equipment furnished under other Divisions.

D. Assemble equipment required to be field assembled under the direct supervision of the manufacturers' agent. Prior to the final acceptance submit letters from the manufacturers that this has been done.

E. Avoid interference with structure and with work of other trades, preserving adequate headroom and clearing doors and passageways, to the satisfaction of the Consultant and in accordance with code requirements. Installation shall permit clearance for access to equipment for repair, servicing and replacement.

F. Install equipment so as to properly distribute equipment loads on building structural members provided for equipment support under other Sections. Roof mounted equipment shall be installed and supported on structural steel provided under other Sections.

G. Provide suspended platforms, strap hangers, brackets, shelves, stands or legs as necessary for floor, wall of ceiling mounting of equipment as required.

H. Provide steel supports and hardware for proper installation of hangers, anchors, guides, etc.

I. Provide cuts, weights, and other pertinent data required for proper coordination of equipment support provisions and installations.

J. Structural steel and hardware shall conform to Standard specifications of ASTM; use of steel and hardware shall conform to requirements of Section V of Code of Practice of American Institute of Steel Construction.

K. Verify site conditions and dimensions of equipment to ensure access for proper installation of equipment without disassembly, which will void warrantee. Report in writing to the Consultant, prior to purchase or shipment of equipment involved, on conditions which may prevent proper installation.

L. Measure indicated mounting heights to center of unit for suspended items and wall-mounted items, unless noted otherwise.

M. 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.

N. Sequence for efficient flow of installation and positioning prior to building closing-in. Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Provide for ease of disconnecting of equipment with minimum interference to other installations.

O. Arrange raceways, cables, wireways, and busways to be clear of obstructions and of the working and access space of other equipment.

P. Give right of way to piping systems installed at a required slope.

Q. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

R. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Refer to Division 08 Section "Access Doors and Frames."

S. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Comply with Division 07 Section "Penetration Firestopping."

T. Comply with Division 01 Section "Cutting and Patching" restoration of surfaces disturbed by electrical installation.

3.15 PAINTING

A. Equipment installed shall have shop coat of non-lead paint. Hangers and supports shall have one coat of non-lead primer. Finish painting, including painting of various conduit or wire way systems, shall be done under other Sections.

B. Paint all outside exposed equipment and equipment supports with two coats of weather resistant enamel.

C. Properly prepare Work under this Division to be finish painted under Division 9.

D. Refer to standard paint colors for all Electrical equipment inside the Building.

E. Paint finished surfaces damaged during electrical installation, matching color and type of paint. Follow manufacturer's written instructions for surface preparation and application. Apply successive coats required to restore finish equal to the unblemished areas.

F. Remove below if not require

3.16 JOBSITE SAFETY

A. Neither the professional activities of the Engineer, nor the presence of the Engineer or his or her employees and sub-consultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Engineer and his or her personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Engineer and the Engineer’s consultants shall be indemnified and shall be made additional insured’s under the Contractor’s general liability insurance policy.

3.17 FINAL JOBSITE OBSERVATION

A. As the work nears completion, the Contractor is to review the requirements of the Contract Documents, inspect the work and inform all parties involved of the work to be corrected or completed before the project can be deemed substantially complete.

B. When the Project is substantially complete, In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation. Notify the Owner's Representative in writing of this fact, listing any items of Work remaining incomplete, the reason therefore, and the anticipated date that all remaining work will be completed. The Contractor shall inform the certification that the project is complete and ready for a final punch, the Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.

C. It is understood that if the Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Engineers additional time and expenses will be deducted from the Contractor’s contract retainage prior to final payment at the completion of the job.

D. The Contractor shall carry out their own final inspection and satisfy the Work.

E. The Owner's Representative reserves the right to cancel and reschedule the inspection in the event considerable more work remains to be completed or corrected than indicated in the written request for inspection.

F. All items not completed or found not complying with drawings or specifications by the Owner’s Representative will be identified in their inspection report.

G. Correct all items on inspection report. Make the correction and initial and date each item on the report after corrections have been completed.

H. Include the fee for all local inspections.

3.18 INSTRUCTING THE OWNER'S REPRESENTATIVES

A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.

B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.

C. The Owner has the option to video tape all instructions. Coordinate schedule of instructions to facilitate this recording.

D. The instructions shall include:

1. Maintenance of equipment.
2. Start-up procedures for all major equipment.
3. Description of emergency system operation.

3.19 PROJECT CLOSE-OUT PROCEDURE

A. General

1. The requirements of this section are in addition to and supplement the requirements outlined in Division 1.
2. It shall be each contractor's responsibility to personally hand-deliver all of the required project close-out checklist items and to obtain Owner's authorized representative(s) signed receipt on all items requiring Owner sign-off.

B. Project Close-Out Checklist

1. Review requirements of each section of the specifications and submit for approval to Consultants the sign-off forms which shall become the project close-out checklist. These, at a minimum, shall include the following information shown in attached Project Closeout Checklist Example. The Consultants and/or Owner may incorporate additional specific items to the checklist which shall become part of project requirements.

R

C. In order to prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

D. Penetrations fire sealed and labeled in accordance with specifications.

E. Electrical panels have typed circuit identification.

F. Operation and Maintenance manuals have been submitted per Specification.

G. Factory startup and reports have been submitted as required.

H. Electric Panels and equipment have been properly labeled.

I. Accepted by:

J. Contractor _____

K. By _____ Date _____

L. Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Engineer so that the final observation can be scheduled.

M. It is understood that if the Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

END OF SECTION 260500

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

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:

1. Copper building wire rated 600 V or less.
2. Metal-clad cable, Type MC, rated 600 V or less.
3. Fire-alarm wire and cable.
4. Connectors, splices, and terminations rated 600 V and less.

B. Related Requirements:

1. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.

1.3 DEFINITIONS

A. RoHS: Restriction of Hazardous Substances.

B. VFC: Variable-frequency controller.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For each conductor and cable indicating lead content.
2. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
3. Product Data: For solvents and adhesives, indicating VOC content.
4. Laboratory Test Reports: For solvents and adhesives, indicating compliance with requirements for low-emitting materials.

PART 2 PRODUCTS

2.1 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Insulated Wire Corp. Bare Conductor
2. General Cable Technologies Corporation.
3. Southwire Company.
4. Alcan Products Corporation; Alcan Cable Division
5. Senator Wire and Cable Comparny

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

E. Conductor Insulation:

1. Type THHN and Type THWN-2: Comply with UL 83.
2. Type XHHW-2: Comply with UL 44.

2.2 METAL-CLAD CABLE, TYPE MC

A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems; a part of Atkore International.
2. Alpha Wire Company.
3. American Bare Conductor.
4. Belden Inc.
5. Encore Wire Corporation.
6. General Cable Technologies Corporation.
7. Okonite Company (The).
8. Service Wire Co.
9. Southwire Company.
10. WESCO.

C. Insert manufacturer's name.Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Comply with UL 1569.
3. RoHS compliant.
4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Circuits:

1. Single circuit and multicircuit with color-coded conductors.
2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.

E. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

F. Ground Conductor: Insulated.

G. Conductor Insulation:

1. Type TFN/THHN/THWN-2: Comply with UL 83.

H. .Armor: Steel or Aluminum, interlocked.

1. Service Wire Co.

2.3 FIRE-ALARM WIRE AND CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Allied Wire & Cable Inc.
2. CommScope, Inc.
3. Comtran Corporation.
4. Draka Cableteq USA; a Prysmian Group company.
5. Genesis Cable Products; Honeywell International, Inc.
6. Radix Wire.
7. Rockbestos-Suprenant Cable Corp.
8. Superior Essex Inc.
9. West Penn Wire.

B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

1. Lead Content: Less than 300 parts per million.

C. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG.

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.

1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.

2.4 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. 3M Electrical Products.
2. AFC Cable Systems; a part of Atkore International.
3. Gardner Bender.
4. Hubbell Power Systems, Inc.
5. Ideal Industries, Inc.
6. ILSCO.
7. NSi Industries LLC.
8. O-Z/Gedney; a brand of Emerson Industrial Automation.
9. Service Wire Co.
10. TE Connectivity Ltd.
11. Thomas & Betts Corporation; A Member of the ABB Group.

C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.

1. Material: Copper.
2. Type: Two hole with standard barrels.
3. Termination: Compression.

PART 3 EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.

D. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type XHHW-2, single conductors in raceway.

B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway,Type XHHW-2, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN/THWN-2, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway Type XHHW-2, single conductors in raceway.

E. Exposed Branch Circuits, Including in Crawlspaces: Type THHN/THWN-2, single conductors in raceway .

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway Metal-clad cable, Type MC.

G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway Type XHHW-2, single conductors in raceway.

H. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

I. VFC Output Circuits: Type XHHW-2 in metal conduit.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

3.4 INSTALLATION OF FIRE-ALARM WIRING

A. Comply with NECA 1 and NFPA 72.

B. Wiring Method: Install wiring in metal pathway according to Section 270528.29 "Hangers and Supports for Communications Systems."

1. Install plenum cable in environmental airspaces, including plenum ceilings.
2. Fire-alarm circuits and equipment control wiring associated with fire-alarm system shall be installed in a dedicated pathway system. This system shall not be used for any other wire or cable.

C. Wiring Method:

1. Cables and pathways used for fire-alarm circuits, and equipment control wiring associated with fire-alarm system, may not contain any other wire or cable.
2. Signaling Line Circuits: Power-limited fire-alarm cables shall not be installed in the same cable or pathway as signaling line circuits.

D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire-alarm system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes; cabinets; or equipment enclosures where circuit connections are made.

F. Color-Coding: Color-code fire-alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire-alarm system junction boxes and covers red.

G. Risers: Install at least two vertical cable risers to serve the fire-alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent receipt or transmission of signals from other floors or zones.

H. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the fire-alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.5 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material.

1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

D. Comply with requirements in Section 283111 "Digital, Addressable Fire-Alarm System" for connecting, terminating, and identifying wires and cables.

3.6 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.7 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.8 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.

2. Perform each of the following visual and electrical tests:

a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
b. Test bolted connections for high resistance using one of the following:

1) A low-resistance ohmmeter.
2) Calibrated torque wrench.
3) Thermographic survey.

c. Inspect compression-applied connectors for correct cable match and indentation.
d. Inspect for correct identification.
e. Inspect cable jacket and condition.

f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
g. Continuity test on each conductor and cable.
h. Uniform resistance of parallel conductors.

3. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.

a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
b. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

4. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

B. Cables will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports to record the following:

1. Procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 260519

SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

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:

1. Backboards.
2. Category 6a balanced twisted pair cable.
3. Balanced twisted pair cabling hardware.
4. RS-485 cabling.
5. Low-voltage control cabling.
6. Control-circuit conductors.
7. Identification products.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

C. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.

D. RCDD: Registered Communications Distribution Designer.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For each conductor and cable indicating lead content.
2. Environmental Product Declaration: For each product.
3. Health Product Declaration: For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
5. Environmental Product Declaration: For each product.
6. Environmental Product Declaration: For each product.
7. Environmental Product Declaration: For each product.
8. Third-Party Certifications: For each product.
9. Third-Party Certified Life Cycle Assessment: For each product.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency, RCDD, layout technician, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. 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.

B. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.

1. Flame Travel Distance: 60 inches or less.
2. Peak Optical Smoke Density: 0.5 or less.
3. Average Optical Smoke Density: 0.15 or less.

C. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

D. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

E. RoHS compliant.

2.2 BACKBOARDS

A. Description: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels in Section 061000 "Rough Carpentry."

B. Painting: Paint plywood on all sides and edges . Comply with requirements in Section 099123 "Interior Painting."

2.3 CATEGORY 6a BALANCED TWISTED PAIR CABLE

A. Comply with requirements for CAT6a in Section 271000 "Information Technology Cable Plant".

2.4 TWISTED PAIR CABLE HARDWARE

A. Comply with requirements for CAT6a in Section 271000 "Information Technology Cable Plant".

2.5 RS-232 CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Allied Wire & Cable Inc.
2. Belden Inc.
3. General Cable Technologies Corporation.
4. Genesis Cable Products; Honeywell International, Inc.
5. Southwire Company.

B. PVC-Jacketed, TIA 232-F:

1. Three, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Lead Content: Less than 300 parts per million.
3. Polypropylene insulation.
4. Aluminum foil-polyester tape shield with 100 percent shield coverage.
5. PVC jacket.
6. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
7. NFPA 70 Type: Type CM.
8. Flame Resistance: Comply with UL 1581.

C. Plenum-Type, TIA 232-F:

1. Three, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Lead Content: Less than 300 parts per million.
3. PE insulation.
4. Aluminum foil-polyester tape shield with 100 percent shield coverage.
5. Fluorinated ethylene propylene jacket.
6. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
7. Flame Resistance: Comply with NFPA 262.
8. Lead Content: Less than 300 parts per million.

2.6 RS-485 CABLE

A. Standard Cable: NFPA 70, Type CMG.

1. Paired, one pair, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1685.
6. Lead Content: Less than 300 parts per million.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, one pair, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.

5. Flame Resistance: NFPA 262.

2.7 LOW-VOLTAGE CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.

1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1685.
6. Lead Content: Less than 300 parts per million.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.
6. Lead Content: Less than 300 parts per million.

2.8 CONTROL-CIRCUIT CONDUCTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Encore Wire Corporation.
2. General Cable; General Cable Corporation.
3. Service Wire Co.
4. Southwire Company.

B. Class 1 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway .

C. Class 2 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

D. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

E. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.

1. Smoke control signaling and control circuits.

2.9 FIRE-ALARM WIRE AND CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Allied Wire & Cable Inc.

2. CommScope, Inc.
3. Comtran Corporation.
4. Draka Cableteq USA; a Prysmian Group company.
5. Genesis Cable Products; Honeywell International, Inc.
6. Radix Wire.
7. Rockbestos-Suprenant Cable Corp.
8. Superior Essex Inc.
9. West Penn Wire.

B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

1. Lead Content: Less than 300 parts per million.

C. Signaling Line Circuits: Twisted, shielded pair, not less than No. 16 AWG.

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.

1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.
3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NTRL listed for fire-alarm and cable tray installation, plenum rated.

2.10 SOURCE QUALITY CONTROL

A. Factory test twisted pair cables according to TIA-568-C.2.

B. Cable will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 EXECUTION

3.1 EXAMINATION

A. Test cables on receipt at Project site.

1. Test each pair of twisted pair cable for open and short circuits.

3.2 INSTALLATION OF RACEWAYS AND BOXES

A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.

1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.
2. Outlet boxes for cables shall be no smaller than 4 inches square by 2-1/8 inches deep with extension ring sized to bring edge of ring to within 1/8 inch of the finished wall surface.
3. Flexible metal conduit shall not be used.

B. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

C. Install manufactured conduit sweeps and long-radius elbows if possible.

D. Raceway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard if entering the room from overhead.
4. Extend conduits 3 inches above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

E. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. Comply with requirements for CAT6a in Section 271513 "Communications Copper Horizontal Cabling".

C. General Requirements for Cabling:

1. Comply with TIA-568-C Series of standards.
2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced and shall be continuous from terminal to terminal. Do not splice cable between termination, tap, or junction points.
5. Cables serving a common system may be grouped in a common raceway. Install network cabling and control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
6. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.

9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
11. Support: Do not allow cables to lie on removable ceiling tiles.
12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
13. Provide strain relief.
14. Keep runs short. Allow extra length for connecting to terminals. Do not bend cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
15. Ground wire shall be copper, and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.

D. Balanced Twisted Pair Cable Installation:

1. Comply with TIA-568-C.2.
2. Install termination hardware as specified in Section 271513 "Communications Copper Horizontal Cabling" unless otherwise indicated.
3. Do not untwist balanced twisted pair cables more than 1/2 inch at the point of termination to maintain cable geometry.

E. Installation of Control-Circuit Conductors:

1. Install wiring in raceways.
2. Use insulated spade lugs for wire and cable connection to screw terminals.
3. Comply with requirements specified in Section 260533 "Raceways and Boxes for Electrical Systems."

F. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 30 inches apart.
3. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 5 inches.
    b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 12 inches.
    c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 6 inches.
c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

a. Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.
b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 3 inches.
c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 REMOVAL OF CONDUCTORS AND CABLES

A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified with a tag for future use.

3.5 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits; No 14 AWG.
2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

3.6 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.7 GROUNDING

A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.

B. For low-voltage control wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.8 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Identify data and communications system components, wiring, and cabling according to TIA-606-B; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.

C. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire shall have a unique tag.

3.9 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

B. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

C. End-to-end cabling will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 260523

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

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 grounding and bonding systems and equipment.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans showing dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:

1. Test wells.
2. Ground rods.
3. Ground rings.
4. Grounding arrangements and connections for separately derived systems.

B. Qualification Data: For testing agency and testing agency's field supervisor.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Plans showing as-built, dimensioned locations of system described in "Field Quality Control" Article, including the following:

1) Test wells.
2) Ground rods.
3) Ground rings.
4) Grounding arrangements and connections for separately derived systems.

b. Instructions for periodic testing and inspection of grounding features at test wells ground rings grounding connections for separately derived systems based on NFPA 70B.

1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
2) Include recommended testing intervals.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Certified by NETA.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

A. 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.

B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Burndy; Part of Hubbell Electrical Systems.
2. ERICO International Corporation.
3. Galvan Industries, Inc.; Electrical Products Division, LLC.
4. Harger Lightning & Grounding.
5. ILSCO.
6. O-Z/Gedney; a brand of Emerson Industrial Automation.
7. Robbins Lightning, Inc.
8. Thomas & Betts Corporation; A Member of the ABB Group.

2.3 CONDUCTORS

A. General requirements for grounding and bonding Conductors:

1. Material: Copper
2. Solid Conductors: ASTM B 3.
3. Stranded Conductors: ASTM B 8.
4. Tinned Conductors: ASTM B 33.
5. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
6. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
7. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

8. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

B. Lead Content: Less than 300 parts per million.

2.4 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression -type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

D. Bus-Bar Connectors: Compression type, copper or copper alloy, with two wire terminals.

E. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

F. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.

G. Conduit Hubs: Mechanical type, terminal with threaded hub.

H. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

I. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

J. Lay-in Lug Connector: Mechanical type, aluminum terminal with set screw.

K. Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud lengths, capable of single and double conductor connections.

L. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.

M. Straps: Solid copper, copper lugs. Rated for 600 A.

N. Tower Ground Clamps: Mechanical type, copper or copper alloy, terminal [one] [two]-piece clamp.

O. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.

P. Water Pipe Clamps:

1. Mechanical type, two pieces with zinc-plated bolts.

a. Material: [Tin-plated aluminum] [Die-cast zinc alloy].
b. Listed for direct burial.

2. U-bolt type with malleable-iron clamp and copper ground connector rated for direct burial.

Q. Lead Content: Less than 300 parts per million.

2.5 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet.

2.6 GROUNDING BUSBARS

A. Grounding Busbars: Predrilled rectangular bars of annealed copper, with stand-off insulators for mounting.

1. Main Electrical Room Grounding Busbar: 24 by 4 by 1/4 inches, 7/16 inch holes, pattern AA.
2. Electrical Closet Grounding Busbar: 12 by 2 by 1/4 inches, 7/16 inch holes, pattern GG.

PART 3 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.

1. Bury at least 30 inches below grade.
2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.

C. Grounding Conductors: Green-colored insulation with continuous yellow stripe.

D. Isolated Grounding Conductors: Green-colored insulation with more than one 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.

E. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches 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, and down; connect to horizontal bus.

F. 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 AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

3.4 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

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. Metal-clad cable runs.

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. 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.

3.5 INSTALLATION

A. 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.

B. Ground Bonding Common 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.

C. Ground Rods: Drive rods until tops are 2 inches 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. Use exothermic welds for all below-grade connections.
3. 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.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.

1. 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.

E. 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 bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

F. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by 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.

G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

H. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each indicated item, extending around the perimeter of building.

1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
2. Bury ground ring not less than 24 inches from building's foundation.

I. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods

    a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by fall-of-potential method according to IEEE 81.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm(s).
5. Substations and Pad-Mounted Equipment: 5 ohms.

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specification Sections and Section 260500 œ Common Work Results for Electrical shall apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 ACTION SUBMITTALS

A. Product Data: For the slotted support systems.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Equipment supports.

1.6 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate size and location of concrete bases with equipment submitted and provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

PART 2 PRODUCTS

2.1 SLOTTED SUPPORT SYSTEMS

A. Slotted Support Systems: Factory-fabricated components for field assembly.

B. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Cooper B-Line.
2. ERICO.
3. Thomas & Betts.
4. Unistrut.
5. Wesanco.

C. Steel Slotted Support Systems: Comply with MFMA-4.

1. Metallic Coatings: Pre-galvanized for interior applications, hot-dip galvanized after fabrication for exterior applications.
2. Nonmetallic Coatings: Manufacturer's standard PVC coating.
3. Painted Coatings: Manufacturer's standard painted coating.

D. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- diameter holes at a maximum of 8 inches o.c., in at least 1 surface.

1. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items. Materials to be same as channels and angles.

E. Channel Dimensions and Rated Strength: Selected for applicable load criteria.

2.2 RACEWAY AND CABLE SUPPORTS

A. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

B. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron or Pull box with insulating support cleats .

D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

2.3 ANCHORING

A. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   a. Manufacturers: Subject to compliance with requirements, provide products by the following:

      1) Hilti.
      2) ITW Ramset/Red Head.
      3) MKT Fastening.
      4) Simpson Strong-Tie.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      1) Cooper B-Line.
      2) Empire Tool and Manufacturing.
      3) Hilti.
      4) ITW Ramset/Red Head.
      5) MKT Fastening.
      6) Simpson Strong-Tie.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.4 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
6. To Light Steel: Sheet metal screws.

7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases not less than 4 inches (100 mm) high and larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.

C. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."

D. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install epoxy-coated anchor bolts to elevations required for proper attachment to supported equipment, according to manufacturer¢s written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Section 099123 "Interior Painting" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

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 raceways, wireways, fittings, boxes, enclosures, and cabinets.

B. Related Requirements:

1. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, and underground utility construction
2. Section 262726 ÓWiring Devices• for poke-through assemblies with receptacles, telecommunications, and audio-visual components.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. ENT: Electrical Nonmetallic tubing.

C. FMC: Flexible metal conduit.

D. HDPE: High density polyethylene conduit.

E. IMC: Intermediate metal conduit.

F. LFMC: Liquidtight flexible metal conduit.

G. LFNC: Liquidtight flexible nonmetallic conduit.

H. PVC: Rigid polyvinyl chloride conduit.

I. RMC: Rigid metal conduit.

J. RTRC: Reinforced thermosetting resin conduit.

K. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

1.4 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.

C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

D. Coordination Drawings: Conduit routing plans for feeders, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
3. Electrical busway.
4. Pull boxes
5. Electrical equipment including switchboards, panelboards and disconnect switches rated 60A and larger.

1.5 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate final location of furniture and floor boxes with Architect.

PART 2 PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. AFC Cable Systems.
2. Allied Tube & Conduit.
3. Anamet Electrical.
4. Electri-Flex.
5. O-Z/Gedney.
6. Picoma.
7. RACO.
8. Republic Conduit.
9. Robroy Industries.
10. Thomas & Betts.
11. Western Tube and Conduit.
12. Wheatland Tube Company.

B. Rigid:

1. RMC: Comply with ANSI C80.1 and UL 6 for galvanized steel.Comply with ANSI C80.1 and UL 6A for stainless steel.
2. IMC: Comply with ANSI C80.6 and UL 1242.
3. EMT: Comply with ANSI C80.3 and UL 797.

C. Flexible:

1. FMC: Comply with UL 1; zinc-coated steel.
2. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

D. Fittings: Comply with NEMA FB 1 and UL 514B.

1. RMC and IMC: Threaded rigid steel conduit fittings unless otherwise indicated.
2. PVC Coated Steel Conduit: Listed for use with this type of conduit. Minimum coating thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
3. EMT: Compression, steel fittings.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit.
5. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

E. Joint Compound for IMC and RMC: Compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Allied Tube & Conduit. for PVC only
2. CANTEX. for PVC, LFNC, fittings
3. Carlon.for PVC, LFNC, fittings

B. Rigid:

1. PVC: Type EPC, Schedule 80, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

C. Fittings: Compatible with raceways and suitable for use and location.

1. PVC: Comply with NEMA TC 3; match to conduit or tubing type and material.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper B-Line, Inc.
2. Hoffman; a Pentair company.
3. Square D.

B. Description: Sheet metal with manufacturer¢s standard enamel finish , complying with UL 870 and NEMA 250, Type 1 and Type 3R unless otherwise indicated, and sized according to NFPA 70.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

2.4 BOXES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Crouse-Hinds.
2. O-Z/Gedney.
3. RACO.
4. Thomas & Betts.

B. General Requirements for Boxes: Boxes installed in wet locations shall be listed for use in wet locations.

C. Outlet and Device Boxes: Gangable boxes are prohibited.

1. Sheet Metal: Comply with NEMA OS 1 and UL 514A.
2. Cast-Metal: Comply with NEMA FB 1, ferrous alloy aluminum, Type FD, with gasketed cover.
3. Dimensions:

   a. Power: 4 inches square by 2-1/8 inches deep or 4 inches by 2-1/8 inches by 2-1/8 inches deep.
   b. Low Voltage: : 4 inches square by 2-1/8 inches deep or 4 inches by 2-1/8 inches by 2-1/8 inches deep.

D. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

E. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.

F. Access, Pull, and Junction Boxes:

1. Small Sheet Metal: Comply with NEMA OS 1 and UL514A.
2. Large Sheet Metal: Comply with UL50.
3. Cast-Metal: Comply with NEMA FB 1 and UL 1773, cast aluminum or galvanized, cast iron with gasketed cover.

G. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

2.5 ENCLOSURES AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Crouse-Hinds.
2. Hoffman.
3. Milbank.
4. O-Z/Gedney.
5. Wiegmann.

B. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 and Type 3R with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2.
3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

C. Cabinets:

1. NEMA 250, Type 1 and Type 3R galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

2.6 FITTINGS AND BOXES FOR HAZARDOUS (CLASSIFIED) LOCATIONS

A. Manufacturers: Subject to compliance with project requirements, provide products by one of the following;

1. Adalet.
2. Appleton Electric.
3. Cooper Crouse-Hinds.
4. Killark.

B. Conduit Fittings and Boxes for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.

2.7 FLOOR BOXES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Basis of Design Manufacturer: FSR.
2. Alternate manufacturers: subject to compliance with project requirements

    a. Thomas & Betts.
    b. Wiremold.
    c. Hubbell

B. Floor Boxes: Modular, flap-type, dual-service units suitable for floor type and depth.

1. Metal Floor Boxes: Cast metal or sheet metal, fully adjustable.
2.
3. Faceplate Shape: Round.

C. Compartments: Barrier separates power from voice and data communication cabling.

D. Service Plate finish: As selected by Architect

E. Modular Mounting Plates: Provide as required for quantities and types of devices as indicated on Drawings.

1. Receptacles: Provide quantity as indicated on Drawings, comply with requirements in Section 262726 ÓWiring Devices• .
2. Voice and Data Communication Outlets: Blank cover with bushed cable opening
3. Audio and Visual Outlets: Blank cover with bushed cable opening .

F. Listing and Labeling:

1. Metal and nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.8 SURFACE RACEWAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hubbell Wiring Device Ó Kellems.
2. Mono-Systems.
3. Wiremold.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.

C. Number of channels indicated on drawings, with divider accessories as required.

D. Provide fittings and accessories including, but not limited to, elbows, couplings, wire clips, end fittings, device mounting brackets, and plates as required for a complete system. Provide accessories suitable for devices, outlets, and wiring and cable as indicated on Drawings.

PART 3 EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: Galvanized steel, IMC.
2. Concealed Conduit, Aboveground: Galvanized steel, IMC.
3. Underground Conduit (branch circuits): Schedule 80 PVC, direct buried.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.

2. Exposed and Subject to Physical Damage: Galvanized steel or IMC. Raceway locations include the following:

   a. Loading dock.
   b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
   c. Mechanical rooms.

3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
4. Embedded in slabs: Schedule 40 PVC
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Conduit in Damp or Wet Locations: Galvanized steel or IMC.
7. Conduit in Wet Locations: Galvanized steel or IMC.
8. Boxes and Enclosures: NEMA 250, Type 1
9. Boxes and Enclosures in Commercial Kitchens or Wet Locations: NEMA 250, Type 4 or 4X stainless steel.

C. Minimum Raceway Size: 3/4-inch trade size for aboveground conduit, 1-inch for underground conduit unless otherwise noted on drawings.

D. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

E. Raceway Fittings: Compatible with raceways and suitable for use and location. Comply with NEMA FB 2.10 for rigid and NEMA FB 2.20 for flexible.

F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

G. Install surface raceways only where indicated on Drawings.

3.2 INSTALLATION OF RACEWAYS

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Comply with NECA 102 for aluminum conduit.

C. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

D. Complete raceway installation before starting conductor installation.

E. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

F. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports. Support conduit within 12 inches of enclosures to which attached.

G. Arrange stub-ups so curved portions of bends are not visible above finished slab.

H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

I. Install no more than the equivalent of two 90-degree bends in any conduit run for communication wiring. Support within 12 inches of changes in direction.

J. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

K. Support conduit within 12 inches of enclosures to which attached.

L. Raceways Embedded in Concrete and Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Arrange raceways to keep a minimum of 2 inchof concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
5. Confirm with structural engineer placement restrictions of all raceway embedded in slabs before installation.

M. Stub-ups to Above Recessed Ceilings: Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

N. Low-Voltage Raceways:

1. Comply with TIA-569-B for pull-box sizing and length of conduit and number of bends between pull points.
2. Install manufactured conduit sweeps and long-radius elbows if possible.
3. Install no more than the equivalent of two 90-degree bends.
4. Raceway Installation in Equipment Rooms:

    a. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
    b. Install cable trays to route cables if conduits cannot be located in these positions.
    c. Secure conduits to backboard if entering the room from overhead.
    d. Extend conduits 3 inches above finished floor.

5. Flexible conduit shall not be used.

3.3 INSTALLATION OF FITTINGS AND JOINTS

A. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

B. Terminate threaded conduits into threaded hubs..

C. Install insulating bushings or insulated throat metal bushings on all conduits and fittings.

D. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

E. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with 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 according to NFPA 70.

F. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Where otherwise required by NFPA 70.

G. Expansion-Joint Fittings:

1. Install type and quantity of fittings to accommodate temperature changes:

a. Provide fittings for temperature change listed for each of the following locations:

1) Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
2) Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
3) Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
4) Attics: 135 deg F temperature change.
5) Metallic Conduit: Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.

b. Minimum Expansion and Contraction:

1) Nonmetallic: Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change
2) Metallic: Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change.

2. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

3.4 INSTALLATION OF BOXES, ENCLOSURES, AND CABINETS

A. Mount boxes at heights indicated on Architectural Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

B. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

C. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

D. Locate boxes so that cover or plate will not span different building finishes.

E. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

F. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

G. Set metal floor boxes level and flush with finished floor surface.

H. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

I. Mount cabinets and enclosures plumb and rigid without distortion of box. Mount recessed cabinets and enclosures with fronts uniformly flush with wall finish and mating with cover.

3.5 INSTALLATION OF SURFACE RACEWAYS

A. Install surface raceway with a minimum 2-inch radius control at bend points.

B. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

3.6 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.
3. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.

END OF SECTION 260533

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

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:

1. Rigid nonmetallic duct.
2. Duct accessories.

1.3 DEFINITIONS

A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.

B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.

C. Duct Bank:

1. Two or more ducts installed in parallel, with or without additional casing materials.
2. Multiple duct banks.

D. GRC: Galvanized rigid (steel) conduit.

E. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include duct-bank materials, including spacers and miscellaneous components.
2. Include duct, conduits, and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
3. Include accessories for manholes, handholes, boxes, and other utility structures.
4. Include underground-line warning tape.
5. Include warning planks.

B. Shop Drawings:

1. Precast or Factory-Fabricated Underground Utility Structures:

a. Include plans, elevations, sections, details, attachments to other work, and accessories.
b. Include duct entry provisions, including locations and duct sizes.
c. Include reinforcement details.
d. Include frame and cover design and manhole chimneys.
e. Include ladder details.
f. Include grounding details.
g. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
h. Include joint details.

2. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:

a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
b. Include duct entry provisions, including locations and duct sizes.
c. Include cover design.
d. Include grounding details.
e. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.5 INFORMATIONAL SUBMITTALS

A. Duct and Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
2. Drawings shall be signed and sealed by a qualified professional engineer.

B. Qualification Data: For professional engineer and testing agency responsible for testing nonconcrete handholes and boxes.

C. Product Certificates: For concrete and steel used in precast concrete manholes, as required by ASTM C 858.

D. Source quality-control reports.

E. Field quality-control reports.

1.6 MAINTENANCE MATERIALS SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Furnish cable-support stanchions, arms, insulators, and associated fasteners in quantities equal to 5 percent of quantity of each item installed.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

1.8 FIELD CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

B. Ground Water: Assume ground-water level is at grade level unless a lower water table is noted on Drawings.

C. Ground Water: Assume ground-water level is 36 inches below ground surface unless a higher water table is noted on Drawings.

PART 2 PRODUCTS

2.1 RIGID NONMETALLIC DUCT

A. Underground Plastic Utilities Duct: Type EPC-80-PVC Type EPC-40-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.

B. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. ARNCO Corp.
2. Beck Manufacturing.
3. CANTEX INC.
4. CertainTeed Corporation.
5. Condux International, Inc.
6. Crown Line Plastics.
7. ElecSys, Inc.
8. Electri-Flex Company.
9. Endot Industries Inc.
10. IPEX USA LLC.
11. Lamson & Sessions.
12. Manhattan/CDT.
13. National Pipe & Plastics.
14. Opti-Com Manufacturing Network, Inc (OMNI).
15. Spiraduct/AFC Cable Systems, Inc.

C. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

D. Solvents and Adhesives: As recommended by conduit manufacturer.

1. VOC Content:510 g/L or less for PVC conduit and fittings.

2.2 DUCT ACCESSORIES

A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.

1. Manufacturers: Subject to compliance with requirements, provide products by the following :
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. Allied Tube & Conduit; a part of Atkore International.
b. CANTEX INC.
c. Carlon; a brand of Thomas & Betts Corporation.
d. IPEX USA LLC.
e. PenCell Plastics.
f. Underground Devices, Inc.

B. Underground-Line Warning Tape: Comply with requirements for underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."

C. Concrete Warning Planks: Nominal 12 by 24 by 3 inches in size, manufactured from 6000-psi concrete.

1. Color: Red dye added to concrete during batching.
2. Mark each plank with "ELECTRIC" in 2-inch- high, 3/8-inch- deep letters.

2.3 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

PART 3 EXECUTION

3.1 PREPARATION

A. Coordinate layout and installation of duct, duct bank, with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Architect.

C. Clear and grub vegetation to be removed, and protect vegetation to remain according to Section 311000 "Site Clearing." Remove and stockpile topsoil for reapplication according to Section 311000 "Site Clearing."

3.2 UNDERGROUND DUCT APPLICATION

A. Duct for Electrical Feeders 600 V and Less: Type EPC-80-PVC Type , concrete-encased unless otherwise indicated.

B. Stub-ups: Concrete-encased GRC.

3.3 EARTHWORK

A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restoration: Replace area immediately after backfilling is completed .

C. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."

E. Cut and patch existing pavement in the path of underground duct, duct bank, and underground structures according to "Cutting and Patching" Article in Section 017300 "Execution."

3.4 DUCT AND DUCT-BANK INSTALLATION

A. Where indicated on Drawings, install duct, spacers, and accessories into the duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.

B. Install duct according to NEMA TCB 2.

C. Slope: Pitch duct a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from a high point between two manholes, to drain in both directions.

D. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations unless otherwise indicated.

1. Duct shall have maximum of two 90 degree bends or the total of all bends shall be no more 180 degrees between pull points.

E. Joints: Use solvent-cemented joints in duct and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent duct do not lie in same plane.

F. Installation Adjacent to High-Temperature Steam Lines: Where duct is installed parallel to underground steam lines, perform calculations showing the duct will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.

G. End Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch duct, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell, without reducing duct slope and without forming a trap in the line.
2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line direct-buried duct with calculated expansion of more than 3/4 inch.
3. Grout end bells into structure walls from both sides to provide watertight entrances.

H. Terminator Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches o.c. for 4-inch duct, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to terminator spacing 10 feet from the terminator, without reducing duct line slope and without forming a trap in the line.
2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line duct with calculated expansion of more than 3/4 inch.

I. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 feet outside the building wall, without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for RNC-to-GRC transition. Install GRC penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

J. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

K. Pulling Cord: Install 200-lbf- test nylon cord in empty ducts.

L. Concrete-Encased Ducts and Duct Bank:

1. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes less than 6 inches in nominal diameter.
2. Width: Excavate trench 12 inches wider than duct on each side.
3. Width: Excavate trench 3 inches wider than duct on each side.
4. Depth: Install so top of duct envelope is at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.

5. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
6. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
7. Minimum Space between Duct: 3 inches between edge of duct and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and communications ducts.
8. Elbows: Use manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct run.

    a. Couple RNC duct to GRC with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
    b. Stub-ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

        1) Stub-ups shall be minimum 4 inchesabovefinished floor and minimum 3 inchesfrom conduit side to edge of slab

    c. Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment.

        1) Stub-ups shall be minimum 4 inchesabovefinished floor and no less than 3 inchesfrom conduit side to edge of slab

9. Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
10. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
11. Concrete Cover: Install a minimum of 3 inches of concrete cover between edge of duct to exterior envelope wall, 2 inches between duct of like services, and 4 inches between power and communications ducts.
12. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

    a. Start at one end and finish at the other, allowing for expansion and contraction of duct as its temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written instructions, or use other specific measures to prevent expansion-contraction damage.
    b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing-rod dowels extending a minimum of 18 inches into concrete on both sides of joint near corners of envelope.

13. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.

M. Direct-Buried Duct and Duct Bank:

1. Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements in Section 312000 "Earth Moving" for preparation of trench bottoms for pipes less than 6 inches in nominal diameter.
2. Width: Excavate trench 12 inches wider than duct on each side.
3. Width: Excavate trench 3 inches wider than duct on each side.
4. Depth: Install top of duct at least 36 inches below finished grade unless otherwise indicated.
5. Set elevation of bottom of duct bank below frost line.
6. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
7. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
8. Install duct with a minimum of 3 inches between ducts for like services and 6 inches between power and communications duct.
9. Install manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct.

    a. Couple RNC duct to GRC with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
    b. Stub-ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

        1) Stub-ups shall be minimum 4 inchesabovefinished floor and minimum 3 inchesfrom conduit side to edge of slab

    c. Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment.

        1) Stub-ups shall be minimum 4 inchesabovefinished floor and no less than 3 inchesfrom conduit side to edge of slab

10. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.

    a. Place minimum 3 inches of sand as a bed for duct. Place sand to a minimum of 6 inches above top level of duct.
    b. Place minimum 6 inches of engineered fill above concrete encasement of duct.

N. Warning Planks: Bury warning planks approximately 12 inches above direct-buried duct, placing them 24 inches o.c. Align planks along the width and along the centerline of duct or duct bank. Provide an additional plank for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional planks 12 inches apart, horizontally.

O. Underground-Line Warning Tape: Bury nonconducting underground line specified in Section 260553 "Identification for Electrical Systems" no less than 12 inches above all concrete-encased duct and duct banks and approximately 12 inches below grade. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

3.5 GROUNDING

A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 12-inch- long mandrel equal to duct size minus 1/4 inch. If obstructions are indicated, remove obstructions and retest.
3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

C. Prepare test and inspection reports.

3.7 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump.

1. Sweep floor, removing dirt and debris.
2. Remove foreign material.

END OF SECTION 260543

SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

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 sleeves and seals for raceway and cable penetrations of non-fire-rated construction.

B. Related Requirements:

1. Division 07 Section "Penetration Firestopping" for firestopping raceway and cable penetrations of fire-rated construction and smoke barriers..

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.

PART 2 PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
3. Circular Metal Sleeves: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
4. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

B. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Advance Products & Systems.
b. CALPICO.
c. Metraflex.
d. Pipeline Seal and Insulator.

2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Carbon steel or Stainless steel.
4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, or Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Presealed Systems.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
2. Sealant shall have VOC content complying with LEED.

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 EXECUTION

3.1 APPLICATIONS FOR NON-FIRE-RATED PENETRATIONS

A. Sleeves: Install sleeves unless core-drilled holes or formed openings are used.

1. Interior Concrete and Masonry-Unit Walls and Floors: Steel pipe, unless arrangement requires rectangular sleeved opening.
2. Gypsum Board Assemblies: Circular metal sleeves, unless arrangement requires rectangular sleeved opening.
3. Roof: Flexible boot-type flashing units.
4. Aboveground Exterior Wall: Steel pipe.
5. Underground Exterior Walls and Walls: Sleeve-seal system.

B. Seals:

1. Interior Concrete and Masonry-Unit Walls and Floors:

a. For Annular Space Between Sleeve and Raceway or Cable: Joint sealant complying with requirements of Division 07 Section ÓJoint Sealants.•
b. Space Outside of Sleeves: Grout.

2. Gypsum Board Assemblies: Approved joint compound.
3. Aboveground Exterior Wall: Mechanical sleeve seals.
4. Underground Exterior Walls and Floors: Sleeve-seal system.

3.2 SLEEVE INSTALLATION FOR NON-FIRE-RATED PENETRATIONS

A. Sleeves for Above-Grade Concrete and Masonry-Unit Floors and Walls:

1. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.
2.
3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
4. Install sleeves during erection of walls and floors. Deburr after cutting.

a. Wall Penetrations: Cut sleeves to length for mounting flush with both surfaces of walls.
b. Floor Penetrations: Extend sleeves installed in floors 2 inches above finished floor level.

B. Sleeves for Gypsum Board Assemblies: Install sleeves and seal space outside of sleeves.

C. Roof-Penetration Sleeves: Install sleeves in coordination with roofing work.

D. Aboveground, Exterior-Wall Penetrations: Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Underground Exterior Wall and Floor Penetrations: Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install 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.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 260544

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

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:

1. Color and legend requirements for raceways, conductors, and warning labels and signs.
2. Labels.
3. Bands and tubes.
4. Tapes and stencils.
5. Tags.
6. Signs.
7. Cable ties.
8. Paint for identification.
9. Fasteners for labels and signs.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.

B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

D. Delegated-Design Submittal: For arc-flash hazard study.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with ASME A13.1 and IEEE C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Comply with NFPA 70E and Section 260574 "Overcurrent Protective Device Arc-Flash Study" requirements for arc-flash warning labels.

F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

A. Raceways and Cables Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder branch-circuit conductors.

1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
2. Colors for 208/120-V Circuits:

a. Phase A: Black.
b. Phase B: Red.
c. Phase C: Blue.

3. Colors for 240-V Circuits:

a. Phase A: Black.
b. Phase B: Red.

4. Colors for 480/277-V Circuits:

a. Phase A: Brown.
b. Phase B: Orange.
c. Phase C: Yellow.

5. Color for Neutral: White gray.
6. Color for Equipment Grounds: Bare copper Green Green with a yellow stripe.
7. Colors for Isolated Grounds: Green with white stripe.

C. Raceways and Cables Carrying Circuits at More Than 600 V:

1. Black letters on an orange field.
2. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."

D. Warning Label Colors:

1. Identify system voltage with black letters on an orange background.

E. Warning labels and signs shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.3 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Brady Corporation.
b. Champion America.
c. emedco.
d. Grafoplast Wire Markers.
e. HellermannTyton.
f. LEM Products Inc.
g. Marking Services, Inc.
h. Panduit Corp.
i. Seton Identification Products.

B. Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Brady Corporation.
b. HellermannTyton.
c. Marking Services, Inc.
d. Panduit Corp.
e. Seton Identification Products.

C. Self-Adhesive Wraparound Labels: Preprinted Write-on, 3-mil- thick, polyester vinyl flexible label with acrylic pressure-sensitive adhesive.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. A'n D Cable Products.
b. Brady Corporation.
c. Brother International Corporation.
d. emedco.
e. Grafoplast Wire Markers.
f. Ideal Industries, Inc.
g. LEM Products Inc.
h. Marking Services, Inc.
i. Panduit Corp.
j. Seton Identification Products.

2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
3. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

D. Self-Adhesive Labels: Polyester Vinyl, thermal, transfer-printed, 3-mil- thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. A'n D Cable Products.
b. Brady Corporation.
c. Brother International Corporation.
d. emedco.
e. Grafoplast Wire Markers.
f. HellermannTyton.
g. Ideal Industries, Inc.
h. LEM Products Inc.
i. Marking Services, Inc.
j. Panduit Corp.
k. Seton Identification Products.

2. Minimum Nominal Size:

a. 1-1/2 by 6 inchesfor raceway and conductors
b. 3-1/2 by 5 inchesfor equipment.
c. As required by authorities having jurisdiction.

2.4 BANDS AND TUBES

A. Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters and that stay in place by gripping action.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Brady Corporation.
b. Marking Services, Inc.
c. Panduit Corp.

B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of 200 deg F. Comply with UL 224.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Brady Corporation.
b. Panduit Corp.

2.5 TAPES AND STENCILS

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Carlton Industries, LP.
b. Champion America.
c. Ideal Industries, Inc.
d. Marking Services, Inc.
e. Panduit Corp.

B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Brady Corporation.
b. Carlton Industries, LP.
c. emedco.
d. Marking Services, Inc.

C. Tape and Stencil: 4-inch- wide black stripes on 10-inch centers placed diagonally over orange background and is 12 inches wide. Stop stripes at legends.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. LEM Products Inc.
b. Marking Services, Inc.
c. Seton Identification Products.

D. Floor Marking Tape: 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with black and white yellow and black stripes and clear vinyl overlay.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Carlton Industries, LP.
b. Seton Identification Products.

E. Underground-Line Warning Tape:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Brady Corporation.
b. Ideal Industries, Inc.
c. LEM Products Inc.
d. Marking Services, Inc.
e. Reef Industries, Inc.
f. Seton Identification Products.

2. Tape:

a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
b. Printing on tape shall be permanent and shall not be damaged by burial operations.
c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

3. Color and Printing:

a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE" .
c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE" .

4. Tag: Type I:

a. Pigmented polyolefin, bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
b. Width: 3 inches.
c. Thickness: 4 mils.
d. Weight: 18.5 lb/1000 sq. ft..
e. Tensile according to ASTM D 882: 30 lbf and 2500 psi.

5. Tag: Type II:

a. Multilayer laminate, consisting of high-density polyethylene scrim coated with pigmented polyolefin; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
b. Width: 3 inches.
c. Thickness: 12 mils.
d. Weight: 36.1 lb/1000 sq. ft..
e. Tensile according to ASTM D 882: 400 lbf and 11,500 psi.

6. Tag: Type ID:

a. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
b. Width: 3 inches.
c. Overall Thickness: 5 mils.
d. Foil Core Thickness: 0.35 mil.
e. Weight: 28 lb/1000 sq. ft..
f. Tensile according to ASTM D 882: 70 lbf and 4600 psi.

7. Tag: Type IID:

a. Reinforced, detectable three-layer laminate, consisting of a printed pigmented woven scrim, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.

b. Width: 3 inches.
c. Overall Thickness: 8 mils.
d. Foil Core Thickness: 0.35 mil.
e. Weight: 34 lb/1000 sq. ft..
f. Tensile according to ASTM D 882: 300 lbf and 12,500 psi.

F. Stenciled Legend: In nonfading, waterproof, black Insert color ink or paint. Minimum letter height shall be 1 inch.

2.6 TAGS

A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Brady Corporation.
b. Carlton Industries, LP.
c. emedco.
d. Marking Services, Inc.
e. Seton Identification Products.

B. Nonmetallic Preprinted Tags: Polyethylene tags, 0.015 inch 0.023 inch thick, color-coded for phase and voltage level, with factory screened printed permanent designations; punched for use with self-locking cable tie fastener.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Brady Corporation.
b. Carlton Industries, LP.
c. emedco.
d. Grafoplast Wire Markers.
e. LEM Products Inc.
f. Marking Services, Inc.
g. Panduit Corp.
h. Seton Identification Products.

C. Write-on Tags:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Carlton Industries, LP.
b. LEM Products Inc.
c. Seton Identification Products.

2. Polyester Tags: 0.010 inch 0.015 inch thick, with corrosion-resistant grommet and cable tie for attachment.
3. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
4. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.7 SIGNS

A. Baked-Enamel Signs:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Carlton Industries, LP.
   b. Champion America.
   c. emedco.
   d. Marking Services, Inc.

2. Preprinted aluminum signs, high-intensity reflective, punched or drilled for fasteners, with colors, legend, and size required for application.
3. 1/4-inch grommets in corners for mounting.
4. Nominal Size: 7 by 10 inches.

B. Metal-Backed Butyrate Signs:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Brady Corporation.
   b. Champion America.
   c. emedco.
   d. Marking Services, Inc.

2. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
3. 1/4-inch grommets in corners for mounting.
4. Nominal Size: 10 by 14 inches.

C. Laminated Acrylic or Melamine Plastic Signs:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Brady Corporation.
   b. Carlton Industries, LP.
   c. emedco.
   d. Marking Services, Inc.

2. Engraved legend.
3. Thickness:

   a. For signs up to 20 sq. in., minimum 1/16 inch .
   b. For signs larger than 20 sq. in., 1/8 inch thick.
   c. Engraved legend with black letters on white face.
   d. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting.
   e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.8 CABLE TIES

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Ideal Industries, Inc.
2. Marking Services, Inc.
3. Panduit Corp.

B. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 Deg F according to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black, except where used for color-coding.

C. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 Deg F according to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black.

D. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 Deg F according to ASTM D 638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 EXECUTION

3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

B. Install identifying devices before installing acoustical ceilings and similar concealment.

C. Verify identity of each item before installing identification products.

D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

E. Apply identification devices to surfaces that require finish after completing finish work.

F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.

1. Secure tight to surface of conductor, cable, or raceway.

H. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.

1. Secure tight to surface of conductor, cable, or raceway.

I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

J. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer.

K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

L. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:

1. "EMERGENCY POWER."
2. "POWER."

M. Vinyl Wraparound Labels:

1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.

N. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.

O. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.

P. Self-Adhesive Labels:

1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.

Q. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.

R. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.

S. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.

T. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.

1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.

U. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.

V. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.

W. Underground Line Warning Tape:

1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
2. Limit use of underground-line warning tape to direct-buried cables.
3. Install underground-line warning tape for direct-buried cables and cables in raceways.

X. Metal Tags:

1. Place in a location with high visibility and accessibility.
2. Secure using general-purpose UV-stabilized plenum-rated cable ties.

Y. Nonmetallic Preprinted Tags:

1. Place in a location with high visibility and accessibility.
2. Secure using general-purpose UV-stabilized plenum-rated cable ties.

Z. Write-on Tags:

1. Place in a location with high visibility and accessibility.
2. Secure using general-purpose UV-stabilized plenum-rated cable ties.

AA. Baked-Enamel Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on minimum 1-1/2-inch- high sign; where two lines of text are required, use signs minimum 2 inches high.

BB. Metal-Backed Butyrate Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high sign; where two lines of text are required, use labels 2 inches high.

CC. Laminated Acrylic or Melamine Plastic Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high sign; where two lines of text are required, use labels 2 inches high.

DD. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

C. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil. Stencil legend "DANGER - CONCEALED HIGH-VOLTAGE WIRING" with 3-inch- high, black letters on 20-inch centers.

1. Locate identification at changes in direction, at penetrations of walls and floors, and at 10-foot maximum intervals.

D. Accessible Raceways, Armored and Metal-Clad Cables, More Than 600 V: Vinyl wraparound labels Snap-around labels Self-adhesive labels.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

E. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive raceway labels.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

F. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:

1. "EMERGENCY POWER."
2. "POWER."

G. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use vinyl wraparound labels self-adhesive wraparound labels snap-around labels self-adhesive vinyl tape to identify the phase.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

H. Power-Circuit Conductor Identification, More Than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use write-on tags.

I. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use write-on tags self-adhesive labels with the conductor or cable designation, origin, and destination.

J. Control-Circuit Conductor Termination Identification: For identification at terminations, provide heat-shrink preprinted tubes self-adhesive labels with the conductor designation.

K. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.

L. Auxiliary Electrical Systems Conductor Identification: Self-adhesive vinyl tape that is uniform and consistent with system used by manufacturer for factory-installed connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

M. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.

N. Concealed Raceways and Duct Banks, More Than 600 V, within Buildings: Apply floor marking tape to the following finished surfaces:

1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.
2. Wall surfaces directly external to raceways concealed within wall.
3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.

O. Workspace Indication: Apply floor marking tape tape and stencil to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

P. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.

Q. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels.

1. Apply to exterior of door, cover, or other access.
2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:

    a. Power-transfer switches.
    b. Controls with external control power connections.

R. Arc Flash Warning Labeling: Self-adhesive labels.

S. Operating Instruction Signs: Self-adhesive labels Laminated acrylic or melamine plastic signs.

T. Emergency Operating Instruction Signs: Self-adhesive labels Laminated acrylic or melamine plastic signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer.

U. Equipment Identification Labels:

1. Indoor Equipment: Baked-enamel signs Metal-backed butyrate signs.
2. Outdoor Equipment: Laminated acrylic or melamine sign.
3. Equipment to Be Labeled:

    a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a self-adhesive, engraved, laminated acrylic or melamine label.
    b. Enclosures and electrical cabinets.
    c. Access doors and panels for concealed electrical items.
    d. Switchgear.
    e. Switchboards.
    f. Transformers: Label that includes tag designation indicated on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
    g. Emergency system boxes and enclosures.
    h. Enclosed switches.
    i. Enclosed circuit breakers.
    j. Enclosed controllers.
    k. Push-button stations.
    l. Power-transfer equipment.
    m. Contactors.
    n. Remote-controlled switches, dimmer modules, and control devices.
    o. Battery-inverter units.
    p. Power-generating units.
    q. Monitoring and control equipment.

END OF SECTION 260553

SECTION 260573 - OVERCURRENT PROTECTIVE DEVICE STUDIES

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 computer-based, overcurrent protective device studies including:

1. Coordination Study: Study to determine overcurrent protective device settings for selective tripping.
2. Short-Circuit Study: Study to determine the minimum interrupting capacity of overcurrent protective devices.
3. Arc-Flash Study: Study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.3 DEFINITIONS

A. SCCR: Short-circuit current rating.

1.4 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Other Action Submittals: Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.

1. Input data for studies, including completed computer program input data sheets.
2. Study and equipment evaluation reports; signed, dated, and sealed by a qualified professional engineer.
3.
    a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.
    b. Submit revised single-line diagram, reflecting field investigation results and results of short-circuit study.
4. Electronic file of studies in native software format.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Coordination Study Specialist.

B. Product Certificates: For overcurrent protective device study software, certifying compliance with the following:

1. IEEE 399: For coordination and short-circuit studies.
2. IEEE 1584 and NFPA 70E: For arc-flash study.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For the overcurrent protective devices to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. The following parts from the Overcurrent Protective Device Studies Report:

1) One-line diagram.
2) Protective device coordination study.
3) Short-circuit study.
4) Arc-flash study.
5) Time-current coordination curves.

b. Power system data.
c. Maintenance procedures according to arc-flash requirements in NFPA 70E shall be provided in the equipment manuals.

1.7 QUALITY ASSURANCE

A. Comply with IEEE 399.

B. Comply with IEEE 242.

C. Comply with IEEE 551.

D. Comply with IEEE 1584 and NFPA 70E.

E. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.

F. Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

G. Study Specialist Qualifications: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

1. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.

H. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Field adjustments shall be made by a full-time employee who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.

PART 2 PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Software Developers: Subject to compliance with requirements, provide software by the following:

1. SKM Systems Analysis.
2. Operation Technology, Inc.
3. Power Analytics, Corporation.
4. ESA Inc.

B. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

2.2 GENERAL REPORT CONTENT FOR STUDIES

A. Executive summary.

B. Study descriptions, purpose, basis and scope. Include definition of terms and guide for interpretation of the computer printout.

C. One-line diagram, showing the following:

1. Overcurrent protective device designations and ampere ratings.
2. Cable and conductor size and lengths.

3. Transformer kVA and voltage ratings.
4. Motor designations and kVA ratings.
5. Generator designations and kVA ratings.
6. Electrical distribution equipment designations.

D. Study Input Data: As described in "Power System Data" Article.

E. Comments and recommendations for system improvements, where needed.

2.3 COORDINATION STUDY REPORT CONTENTS

A. Coordination Study:

1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.

a. Phase and Ground Relays:

1) Device tag.
2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
3) Recommendations on improved relaying systems, if applicable.

b. Circuit Breakers:

1) Adjustable pickups and time delays (long time, short time, ground).
2) Adjustable time-current characteristic.
3) Adjustable instantaneous pickup.
4) Recommendations on improved trip systems, if applicable.

c. Fuses: Show current rating, voltage, and class.

B. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
4. Plot the following listed characteristic curves, as applicable:

a. Electrical power utility's overcurrent protective device.
b. Medium-voltage equipment overcurrent relays.
c. Low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
d. Low-voltage circuit-breaker trip devices, including manufacturer's tolerance bands.
e. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.

f. Cables and conductors damage curves.
g. Ground-fault protective devices.
h. Motor-starting characteristics and motor damage points.
i. Generator short-circuit decrement curve and generator damage point.
j. The largest feeder circuit breaker in each motor-control center and panelboard.

5. Provide adequate time margins between device characteristics such that selective operation is achieved.

2.4 SHORT-CIRCUIT STUDY REPORT CONTENTS

A. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.
2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

B. Short-Circuit Study Output:

1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a. Voltage.
b. Calculated fault-current magnitude and angle.
c. Fault-point X/R ratio.
d. Equivalent impedance.

2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a. Voltage.
b. Calculated symmetrical fault-current magnitude and angle.
c. Fault-point X/R ratio.
d. Calculated asymmetrical fault currents:

1) Based on fault-point X/R ratio.
2) Based on calculated symmetrical value multiplied by 1.6.
3) Based on calculated symmetrical value multiplied by 2.7.

3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a. Voltage.
b. Calculated symmetrical fault-current magnitude and angle.
c. Fault-point X/R ratio.
d. No AC Decrement (NACD) ratio.

e. Equivalent impedance.
f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

2.5 ARC-FLASH STUDY REPORT CONTENT

A. Incident Energy and Flash Protection Boundary Calculations:

1. Arcing fault magnitude.
2. Protective device clearing time.
3. Duration of arc.
4. Arc-flash boundary.
5. Working distance.
6. Incident energy.
7. Hazard risk category.
8. Recommendations for arc-flash energy reduction.

2.6 ARC-FLASH WARNING LABELS

A. Comply with requirements in Section 260553 "Identification for Electrical Systems." Produce a 3.5-by-5-inch (76-by-127-mm) thermal transfer label of high-adhesion polyester for each work location included in the analysis. Labels shall be machine printed, with no field-applied markings.

B. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:

1. Location designation.
2. Nominal voltage.
3. Flash protection boundary.
4. Hazard risk category.
5. Incident energy.
6. Working distance.
7. Engineering report number, revision number, and issue date.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.

1. Proceed with studies only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to study may not be used in study.

3.2 POWER SYSTEM DATA

This article is a list of data needed to conduct the overcurrent protective device study. Delete data already shown in the one-line diagram on Drawings. From previous studies, add data that should be considered in the study results.

A. Obtain all data necessary for the conduct of the overcurrent protective device study.

1. Verify completeness of data supplied in the one-line diagram on Drawings. Call discrepancies to the attention of Architect.
2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
3. For existing equipment, whether or not relocated obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers.

B. Gather and tabulate the following input data to support studies. The list below is a guide. Comply with recommendations in the standards listed in the ÓQuality Assurance• article for the amount of detail required to be acquired in the field.

1. Overcurrent Protective Devices: Product data for overcurrent protective devices specified in other Sections and involved in studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Electrical Utility: Obtain power utility impedance or available fault current at the service(s).
3. Multiple Services: Power sources and ties.
4. Full-load current of loads.
5. Voltage level at each bus.
6. Transformers: kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
7. Reactors: Manufacturer and model designation, voltage rating, and impedance.
8. Circuit Breakers: Manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, and current rating.
9. Fuses: Manufacturer and model designation. List type of fuser, melting characteristics, SCCR, and current rating.
10. Relays: Manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
11. Generators: Short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
12. Busways: Manufacturer and model designation, current rating, impedance, lengths, and conductor material.
13. Motors: Horsepower and NEMA MG 1 code letter designation.
14. Low-Voltage Cables and Conductors: Sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
15. Medium-Voltage Cables and Conductors: Sizes, lengths, conductor material, and cable construction and metallic shield performance parameters.
16. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:

    a. Special load considerations, including starting inrush currents and frequent starting and stopping.

b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
d. Generator thermal-damage curve.
e. Ratings, types, and settings of utility company's overcurrent protective devices.
f. Special overcurrent protective device settings or types stipulated by utility company.
g. Time-current-characteristic curves of devices indicated to be coordinated.
h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
j. Electrical distribution equipment ampacity, and SCCR in amperes rms symmetrical.

3.3 OVERCURRENT PROTECTIVE DEVICE STUDY GENERAL REQUIREMENTS

A. Studies shall be based on the device characteristics supplied by device manufacturer.

B. The extent of the electrical power system to be studied is indicated on Drawings.

3.4 COORDINATION STUDY

A. Motor Protection:

1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
2. Select protection for motors served at voltages more than 600 V according to IEEE 620.

B. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

C. Generator Protection: Select protection according to manufacturer's written recommendations and to IEEE 242.

D. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.
2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.

E. Load-Flow and Voltage-Drop Study: Perform a load-flow and voltage-drop study to determine the steady-state loading profile of the system. Analyze power system performance two times as follows:

1. Determine load-flow and voltage drop based on full-load currents obtained in "Power System Data" Article.

2. Determine load-flow and voltage drop based on 80 percent of the design capacity of the load buses.
3. Prepare the load-flow and voltage-drop analysis and report to show power system components that are overloaded, or might become overloaded; show bus voltages that are less than as prescribed by NFPA 70.

F. Motor-Starting Study: Perform a motor-starting study to analyze the transient effect of the system's voltage profile during motor starting. Calculate significant motor-starting voltage profiles and analyze the effects of the motor starting on the power system stability.

1. Prepare the motor-starting study report, noting light flicker for limits proposed by IEEE 141, and voltage sags so as not to affect the operation of other utilization equipment on the system supplying the motor.

3.5 SHORT-CIRCUIT STUDY

A. Begin short-circuit current analysis at the service, extending down to the system overcurrent protective devices as follows:

1. To normal system low-voltage load buses where fault current is 10 kA or less.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.

1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each of the following:

1. Electric utility's supply termination point.
2. Incoming switchgear.
3. Low-voltage switchgear.
4. Control panels.
5. Standby generators and automatic transfer switches.
6. Branch circuit panelboards.
7. Disconnect switches.
8. Distribution panelboards.

3.6 ARC-FLASH STUDY

A. Use the short-circuit study output and the coordination study output for settings of the overcurrent devices.

B. Calculate maximum and minimum contributions of fault-current size.

1. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume no motor load.
2. The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

C. Calculate the arc-flash protection boundary and incident energy at locations in the electrical distribution system where personnel could perform work on energized parts.

D. Include medium- and low-voltage equipment locations, except 240-V ac and 208-V ac systems fed from transformers less than 125 kVA.

E. Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash boundary, considering incident energy of 1.2 cal/sq.cm.

F. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond three to five cycles.
2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).

G. Arc-flash computation shall include both line and load side of a circuit breaker as follows:

1. When the circuit breaker is in a separate enclosure.
2. When the line terminals of the circuit breaker are separate from the work location.

H. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.7 FIELD ADJUSTING

A. Adjust relay and overcurrent protective device settings according to the recommended settings coordination and short-circuit study.

B. Make minor modifications to equipment as required to accomplish compliance with short-circuit and coordination studies.

C. Field adjusments shall be completed by this Contractor.

3.8 ARC-FLASH WARNING LABELS

A. Install the arc-fault warning labels under the direct supervision and control of the Arc-Flash Study Specialist. Apply one arc-flash label for panelboards and disconnects and for each of the following equipment:

1. Low-voltage switchboard.
2. Control panel.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel in the following:

1. Acquaint personnel in the fundamentals of operating the power system in normal and emergency modes.
2. Hand-out and explain the objectives of the coordination study, study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpreting the time-current coordination curves.
3. Explain in the potential arc-flash hazards associated with working on energized equipment and the significance of the arc-flash warning labels.
4. Adjust, operate, and maintain overcurrent protective device settings.

END OF SECTION 260573

SECTION 260923 - LIGHTING CONTROL DEVICES

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:
1. Standalone daylight-harvesting switching and dimming controls.
2. Indoor occupancy and vacancy sensors.
3. Switchbox-mounted occupancy sensors.
4. Emergency shunt relays.

B. Related Requirements:

1. Section 262726 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

1.3 ACTION SUBMITTALS

A. Provide the following in one comprehensive submittal:

1. Product Data: For each type of product.
2. Shop Drawings:

a. Show installation and mounting details for the following:

1) Sensors and sensor modules.

b. Interconnection diagrams showing field-installed wiring.
c. Include diagrams for power, signal, and control wiring.
d. Show location of all devices, including sensors, load controllers, and switches/dimmers for each area on reflected ceiling plans.
e. Provide room/area details including products and sequence of operation for each room or area. Illustrate typical acceptable room/area connection topologies.

1.4 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's warranties.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.

1. Warranty Period: 5 year(s) from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with project requirements, provide products by Basis of Design product:

1. Basis of Design product: Eaton Wavelinx Wireless Connected Lighting (WCL)

2. Or equivalent product by:

a. Legrand Wattstopper

b. Osram Encelium

2.2 Load control devices.

A. Relay Switchpack with 0-10V dimming

1. Plenum rated
2. Integrated, self-contained unit consisting internally of an isolated load switching control relay [and a power supply to provide low voltage power].

a. 20amp 120/277VAC General Purpose
b. 16amp 120/277VAC electronic ballast (LED load)
c. Single class-2 0-10V dimming output (IEC 60929 Annex E) sinks up to 120mA per (40 ÒA max per circuit leakage to line)
d. 0-10V output supports up to 60 ballasts/drivers that draw a standard 2mA each

3. Shall be compatible with electronic ballast, LED, incandescent, magnetic or electronic low voltage, and magnetic or electronic fluorescent, as well as motor loads.
4. Shall be capable of controlling up to 20Amp receptacle or plug loads.
5. Controls incorporate non-volatile memory. Should power be interrupted and subsequently restored, settings and parameters saved in protected memory shall not be lost.
6. Relay Switchpack shall be FCC certified.
7. Relay Switchpack shall be a Class 1 device
8. Power measurement accuracy of 5%, reporting data to the Wireless Area Controller for display on the WaveLinx Mobile Application

2.3 Control devices.

A. Wall-stations

1. Mains powered wireless wallstation providing multi-level control of an area or zone

    a. 120VAC input

2. Shall provide individual button LED indication of status and wireless communication as well as selected button.
3. Controls incorporate non-volatile memory. Should power be interrupted and subsequently restored, settings and parameters saved in protected memory shall not be lost.
4. Wallstation shall be FCC certified.
5. Wallstation shall be a Class 1 device
6. Wireless momentary pushbutton switches in 1 through 6 button configuration; available in white, ivory, grey and black; compatible with wall plates with decorator opening. Wallstations shall include the following features:

    a. Multi-level scene selection
    b. Scene raise/lower
    c. Toggle ON/OFF
    d. Removable buttons for field replacement with engraved buttons and/or alternate color buttons.
    e. Shall be capable of button replacement without removing the switch from the wall.
    f. Intuitive button labeling to match application and load controls.
    g. Pre-defined digital button configurations. Each wallstation shall be shipped with pre-defined digital button configurations which are automatically mapped to specific area/zone controls when added to an area control system
    h. Multiple wallstations may be installed in an area by simply connecting them to the local network. No additional configuration will be required to achieve multi-way switching.
    i. Optional custom labeling is available for application or location specific wallstation button labels.

2.4 SENSORS

A. Ceiling Sensor

1. Sensing mechanism

    a. Infrared: Utilize multiple segmented lens, with internal grooves to eliminate dust and residue build-up.
    b. Daylight: Utilize integrated daylight sensor to provide closed loop daylight dimming control. Each Sensor provides an individual daylight dimming zone to provide highly accurate daylight levels at the work surface throughout the entire space.

2. Power failure memory

    a. Controls incorporate non-volatile memory. Should power be interrupted and subsequently restored, settings and parameters saved in protected memory shall not be lost.

3. Shall be capable of 1,500 square feet of coverage with the ability to reduce to 500 square feet, narrow coverage for hallways and corridors, as well as 180 degree cut off in wallmounted is desired.
4. Products tested in identical manner, complaint to NEMA WD 7 -2011 Occupancy Motion Sensors Standards

5. Sensor shall have time delays from 10 to 20 min
6. All sensors shall provide an LED as a visual means of indication at all times to verify that motion is being detected during both testing and normal operation
7. Sensor is battery powered by standard AA batteries
8. Sensor provides indication of battery life through the WaveLinx Mobile Application
9. Sensor battery life shall be 10 years based on approximately 30 activations and wireless signals per day.
10. Sensors shall monitor changes in occupancy, changes in ambient light levels and communicate digital control commands to light fixtures according to a control strategy.
11. Sensor shall wirelessly transmit occupancy; light level, power to the Area Controller which allows the data to be stored in a central location on premises.
12. Sensors shall be fully adaptive with the ability to have the sensitively and timing to be remotely adjusted to ensure optimal lighting control for any use of the space.
13. Sensors have remotely adjustable settings for dimming levels, occupied/unoccupied light levels, occupancy/vacancy sensing, and sensitivity to changes in motion and changes in ambient light levels.
14. Sensors have the ability to remotely adjust light output to reduced levels and remain at that reduced level for an adjustable time period before turning off when a space is vacant.
15. Programming is stored in each sensor in addition to the Area Controller. Sensors operate independently of from Area Controller, so there cannot be single point failure. Systems must operate so there is no single point of failure.
16. Sets high end trim via priority assigned in profile.

B. Tilemount Daylight Sensor

1. Sensing mechanism

    a. [Daylight]: Utilize Tilemount daylight sensor to provide closed loop daylight dimming control to a circuit of connected fixtures.

2. Power failure memory

    a. Controls incorporate non-volatile memory. Should power be interrupted and subsequently restored, settings and parameters saved in protected memory shall not be lost.

3. Tilemount sensor connects to a control module which supports up to 3Amps of connected fixtures.
4. Tilemount is designed to be installed in a ½•or ¾•ceiling tile within 54• of the control module and connected fixtures.
5. Sensor shall provide unique daylight calibration taking into account for light level at the sensors, work surface and integrated luminaire light output.
6. All sensors shall provide an LED as a visual means of indication and diagnostics.
7. Sensors are RoHS compliant

C. Control Module:

1. Sensor shall connect to a 0-10V dimmable ballast or driver via a control module or connect to a WaveLinx enabled drivers without the use of WaveLinx control module.
2. Sensor shall connect to a controller via a low voltage cable for interior applications.
3. If power dropouts in the event of a brown-out or black-out, when power is restored, the lighting system should recover quickly and automatically return to the last lighting levels. A momentary interruption (1 or 2 seconds) of power should not cause extended periods (20 seconds or more) without lighting while the system reboots and all other electrical equipment is back on.

4. Control Module shall be installed by luminaire manufacturer and is shipped as an integral component to the luminaire.
5. Sensor shall be FCC certified.
6. Sensor shall be a Class 2 device.
7. System shall support user initiated manual demand response and utility or BMS initiated automatic demand response.
8. Control Module Components:

    a. Power Measurement capable of 5% power measurement accuracy.
    b. Controller to include latching relay, to decrease power requirements of the power pack.
    c. Operate Bounce Time: 3 ms. Max.
    d. Max Switching Voltage 277VAC and 125VDC.
    e. Insulation Rating: Class B and Class F.
    f. Operations:

        1) Control Module and Sensor shall communicate energy usage Wireless Area Controller.

    g. Electrical/Connections
    h. Circuit protection:
    i. Listed to UL 916.
    j. FCC Part 15 Class A certified.
    k. Manufacturer to pre-wire control module in fixture.
    l. Control module shall be plenum rated.
    m. Connection between sensors and control module shall be Class 2, 18-24 AWG, stranded or solid depending on the application U.L Classified, PVC insulated or TEFLON jacketed cable suitable for use in plenums.

2.5 SYSTEM AREA CONTROLLER

A. Wireless Area Controller

1. Spaces shall be equipped with an automatic control device to shut off lighting in those areas. This automatic control device shall function on either:

    a. a scheduled basis, using time of day, with an independent program schedule that controls the interior lighting in areas that do not exceed 5,000 square feet and are not more than one floor, or
    b. an occupant sensor that shall turn lighting off within 20 minutes of an occupant leaving a space, or
    c. a signal from another control or alarm system that indicates the area is occupied.

B. Provide Wireless Area Controllers to provide zone controls and achive control intent indicated on the drawings. Each Wireless Area Controller shall have the following capabilities:

1. The Wireless Area Controller is a server class appliance that discovers, programs and manages WaveLinx connected devices, connected sensors and connected Apps.
2. Uses industry standard HTTPS security with AES-128 encryption safeguards the integrity of the entire system. Backups prevent data loss and restore fixtures to operational modes. It constantly monitors areas to ensure that spaces are managed according to the assigned user preferences and tasks being performed.
3. Powered-over-Ethernet (PoE) at 48V device, utilizes the building PoE network switches(by others) or a PoE injector for 120V power and network connection.

4. Maximum CAT 5e cable distance between the Wireless Area Controller and a network PoE switch is 330 feet. Care shall be taken when routing the cable to not exceed the 330-foot limitation including travel distance up and down structures.
5. Wi-Fi access point and wireless client capabilities. Wi-Fi capabilities are automatically disabled if the Wireless Area Controller is physically connected to a building LAN and receives an IP address. Systems that allow multiple simulations methods of network connection (Wi-Fi & LAN) shall not be acceptable.
6. 2.4 GHz Transceiver for IEEE 802.15.4 wireless radio for communication to connected devices and sensors.
7. Shall support AES 128-bit encryption
8. LED indicators for status of various wireless radios and communications.
9. Shall be FCC Part 15 Class A, RoHS certified.
10. Wireless Area Controller connection cables shall be plenum rated.

    a. Shall be Class 2 devices.

C. Scalability and Data Integrity

1. The Wireless Area Controller can be deployed as a dedicated installation managing up to 200 wireless devices (connected devices, connected sensors). When deployed as a dedicated installation the Wireless Area Controller acts as a local wireless access point for Wi-Fi connection method to the WaveLinx Mobile Application.
2. It shall not require internet access or wifi access from the end user or client.

2.6 SOFTWARE AND APPLICATIONS

A. Mobile Application

1. Administrative programming and editing may be conducted via an intuitive iOS or Android mobile application.
2. Mobile Software shall support the following features:

    a. Network discovery of multiple Wireless Area Controllers
    b. Naming and identification of Wireless Area Controllers
    c. Unique administrative login credentials for each Wireless Area Controller
    d. Discovery of wireless devices per Wireless Area Controller (Find Devices)
    e. Creation of at least 16 Areas/Rooms per Wireless Area Controller
    f. Creation at least 16 Zones per area/room
    g. Creation of multiple Occupancy Sets per area/room
    h. Creation of Daylight Sets for each integrated luminaire
    i. At least 6 scene values for each area/room
    j. Definition of schedules for each Wireless Area Controller
    k. Blink identification and reverse identification of each connected devices and sensor
    l. Identified connected devices and sensors will indicate on the Mobile Application their selection by the device icon pulsing on the screen.
    m. Ability to utilize drag and drop, multi select and filter capabilities for easy association of connected devices and sensors to a defined area.

2.7 NETWORK INTERFACE HARDWARE

A. Hardware platform hosting software application and interface to building management system.

B. Capable of supporting up to 500 wireless area controllers

C. Processor: Intel Core i5-7300u vPro Processor

D. Connectivity: Intel Gigabit LAN w/AMT support, (4) USB 3.0 ports and (2) USB 2.0 ports

E. IEC 60950, UL 60950-1 compliant

F. Features: alarms and events, BACnet/IP interface, Public API

2.8 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton
2. Wattstopper
3. Lutron

B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox .

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Occupancy Sensor Operation: manual-on or automatic-on operation as indicated on drawings; with a time delay for turning lights off, adjustable over a minimum range of 1 to 20 minutes.
3. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
4. Switch Rating: Not less than 800-VA ballast or LED load at 120 V, and 800-W incandescent.

C. Wall-Switch Dimmer :

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft. 2100 sq. ft.
2. Sensing Technology: Dual technology - PIR and ultrasonic.
3. Switch Type: SP. SP, dual circuit. SP, manual "on," automatic "off." SP, field-selectable automatic "on," or manual "on," automatic "off."
4. Capable of controlling load in three-way application.
5. Voltage: Match the circuit voltage 120 V .
6. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
7. 0-10V dimming.
8. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.

D. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

2.9 EMERGENCY SHUNT RELAY

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Functional Devices.
2. Lighting Control and Design.
3. WattStopper; a Legrand Group brand.

B. Description: NC, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.

1. Coil Rating: 120 V.
2. 0-10V dimmer override.
3. Compatible with LED lighting

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

D. Coordinate Pre-Installation Pre-Wire Visit With Manufacturer

1. Contractor to coordinate pre-wire visit with local manufacturer representative to ensure proper system function and installation based on approved submittal package.

3.2 SENSOR INSTALLATION

A. Comply with NECA 1.

B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

C. Install and aim sensors in locations to achieve not less than 90-percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.3 CONTACTOR INSTALLATION

A. Comply with NECA 1.

B. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.4 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.

C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 IDENTIFICATION

A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.6 PRODUCT SUPPORT AND SERVICE

A. Factory telephone support shall be available at no cost to the owner. Factory assistance shall consist of solving programming or application questions concerning the control equipment.

3.7 FACTORY COMMISSIONING

A. Upon completion of the installation, the system shall be commissioned by the manufacturer's factory authorized representative who will verify a complete fully functional system.

B. The electrical contractor shall provide both the manufacturer and the electrical engineer with twenty one working days written notice of the system startup and adjustment date.

C. Upon completion of the system commissioning the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the system.

D. Qualifications for factory certified field service engineer:

1. Certified by the equipment manufacturer on the system installed.

E. Make first visit upon completion of installation of WaveLinx Wireless Connected Lighting system:

1. Verify locations of Wireless Area Controllers
2. Verify implementation of Construction Group process
3. Identify connected devices and program using WaveLinx Mobile and Automatic Code Commissioning.
4. Verify that system operation control based on defined sequence of operations (SOO).
5. Obtain sign-off on system functions.

F. Make second visit to demonstrate and educate Owner¢s representative on system capabilities, programming, fine tuning and maintenance.

1. Due to building operations, start-up of WaveLinx Wireless Connected Lighting system may be required outside of normal business hours (Monday through Friday, 7 a.m. to 5 p.m.).

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Lighting control devices will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.9 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.10 DEMONSTRATION

A. Engage Manufacturer representative to provide (1) day on-site system training to Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 260923

SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

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: Distribution and buck-boost, dry-type transformers rated 600 V and less, with capacities up to 1500 kVA.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

B. Shop Drawings:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For transformers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Qualification Data: For testing agency.

C. Source quality-control reports.

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Eaton.
2. General Electric Company.
3. Hammond Power Solutions Inc.
4. Siemens Power Transmission & Distribution, Inc.
5. Square D; by Schneider Electric.

B. Source Limitations: Obtain each transformer type from single source from single manufacturer.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. 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.

C. Transformers Rated 15 kVA and Larger: Comply with NEMA TP 1 energy-efficiency levels as verified by testing according to NEMA TP 2.

D. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.

E. Coils: Continuous windings without splices except for taps.

1. Internal Coil Connections: Brazed or pressure type.

2. Coil Material: Aluminum

F. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.

G. Shipping Restraints: Paint or otherwise color code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NFPA 70, and list and label as complying with UL 1561.

B. Provide transformers that are constructed to withstand seismic forces specified in Section 260548.16 "Seismic Controls for Electrical Systems."

C. Cores: One leg per phase.

D. Enclosure: Ventilated Totally enclosed, nonventilated.

1. NEMA 250, Type 2 Stainless Steel: Core and coil shall be encapsulated within resin compound utilizing a vacuum pressure impregnation process to seal out moisture and air.
2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.

E. Transformer Enclosure Finish: Comply with NEMA 250.

1. Finish Color: Gray.

F. Taps for Transformers 3 kVA and Smaller: None One 5 percent tap above normal full capacity.

G. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity Two 5 percent taps below rated voltage.

H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

I. Insulation Class, Smaller than 30 kVA: 185 deg C, UL-component-recognized insulation system with a maximum of 115-deg C rise above 40-deg C ambient temperature.

J. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 115 -deg C rise above 40-deg C ambient temperature.

K. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.

1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
2. Indicate value of K-factor on transformer nameplate.
3. Unit shall meet requirements of NEMA TP 1 when tested according to NEMA TP 2 with a K-factor equal to one.

L. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
2. Include special terminal for grounding the shield.

M. Neutral: Rated 200 percent of full load current for K-factor rated transformers.

N. Wall Brackets: Manufacturer's standard brackets Wall brackets fabricated from design drawings signed and sealed by a licensed structural engineer.

O. Fungus Proofing: Permanent fungicidal treatment for coil and core.

P. Low-Sound-Level Requirements: Maximum sound levels when factory tested according to IEEE C57.12.91, as follows:

1. 9 kVA and Less: 40dB.
2. 30 to 50 kVA: 45dB .
3. 51 to 150 kVA: 50 dB.
4. 151 to 300 kVA: 55dB .
5. 301 to 500 kVA: 60dB .
6. 501 to 750 kVA: 62dB.
7. 751 to 1000 kVA: 64dB.

2.4 BUCK-BOOST TRANSFORMERS

A. Description: Self-cooled, two-winding dry type, rated for continuous duty and with wiring terminals suitable for connection as autotransformer. Transformers shall be listed and labeled as complying with UL 506 or UL 1561.

1. Standard impedance at 60Hz: 2 percent to 5 percent (up to 10 kVA), 4 percent to 6.5 percent (above 10 kVA).
2. Nameplate Rating: Linear load, 60Hz.
3. Insulation Class: 220 deg C system.
4. Temperature Rise: 150 deg C.
5. Core Construction: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
6. Coil Conductors: Continuous copper windings, with terminations brazed, welded, or bolted.
7. Coil Impregnation: Vacuum impregnated with polyester resin.
8. Sound Level: Not exceeding values listed above for distribution transformers.
9. Enclosure: Ventilated, NEMA 250, Type 3R NEMA 250, Type 12.
10. Terminations: Transformer coils shall terminate in mounting pads. Mounting lugs shall be provided on all units up to and including 270 A ratings.
11. Antivibration pads or isolators shall be used between the transformer core and coil and the enclosure.
12. Ground core and coil assembly to enclosure with a flexible copper grounding strap or equivalent.
13. Mounting:

a. Ventilated Units up to 750 lb: Suitable for wall, floor, or ceiling mounting (drip plate required).

b. Ventilated Units over 750 lb: Suitable for floor mounting only.
c. Encapsulated Units up to 285 lb: Suitable for wall or floor mounting.
d. Encapsulated Units over 285 lb: Suitable for floor mounting only.

14. Seismic: Floor-mounted units comply with Earthquake Loads Section of International Building Code with site-specific parameters of Occupancy Category III and Site Profile Type SD with the seismic forces defined as Spectral Acceleration for Short Periods equal to 1.0 g.

B. Enclosure: Ventilated Encapsulated, NEMA 250, Type 2 NEMA 250, Type 3R NEMA 250, Type 4 NEMA 250, Type 4X NEMA 250, Type 12.

1. Finish Color: Gray NSF/ANSI 49 gray NSF/ANSI 61 gray.

2.5 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution buck-boost transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

2.6 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.

1. Resistance measurements of all windings at the rated voltage connections and at all tap connections.
2. Ratio tests at the rated voltage connections and at all tap connections.
3. Phase relation and polarity tests at the rated voltage connections.
4. No load losses, and excitation current and rated voltage at the rated voltage connections.
5. Impedance and load losses at rated current and rated frequency at the rated voltage connections.
6. Applied and induced tensile tests.
7. Regulation and efficiency at rated load and voltage.
8. Insulation Resistance Tests:

a. High-voltage to ground.
b. Low-voltage to ground.
c. High-voltage to low-voltage.

9. Temperature tests.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall-mounted transformers level and plumb with wall brackets fabricated from design drawings signed and sealed by a licensed structural engineer.

1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
2. Brace wall-mounted transformers as specified in Section 260548.16 "Seismic Controls for Electrical Systems."

B. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.

C. Construct concrete bases according to Section 033000 "Cast-in-Place Concrete" and anchor floor-mounted transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

D. Secure transformer to concrete base according to manufacturer's written instructions.

E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.

F. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections with the assistance of a factory-authorized service representative.

E. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS for dry-type, air-cooled, low-voltage transformers. Certify compliance with test parameters.

F. Remove and replace units that do not pass tests or inspections and retest as specified above.

G. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
2. Perform two follow-up infrared scans of transformers, one at four months and the other at 11 months after Substantial Completion.
3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

H. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.

C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262200

SECTION 262413 - SWITCHBOARDS

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 service and distribution switchboards rated 600 V and less.

1.3 DEFINITIONS

A. SPD: Surge protective device.

1.4 ACTION SUBMITTALS

A. Provide the following in one comprehensive submittal:

1. Product Data: For each type of switchboard, overcurrent protective device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
2. Shop Drawings: For each switchboard and related equipment.

    a. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
    b. Detail enclosure types for types other than NEMA 250, Type 1.
    c. Detail bus configuration, current, and voltage ratings.
    d. Detail short-circuit current rating of switchboards and overcurrent protective devices.
    e. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
    f. Detail utility company's metering provisions with indication of approval by utility company.
    g. Retain first subparagraph below if series rating of overcurrent protective devices is used.
    h.
    i. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
    j. Retain first subparagraph below if final system short-circuit and coordination studies will be performed by designer or assigned to independent consultant. These curves are also beneficial to Owner for future additions or reevaluations of settings of overcurrent protective devices.

k. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Include selectable ranges for each type of overcurrent protective device.
l. Retain first subparagraph below if mimic bus is specified.
m. Include schematic and wiring diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for switchboards and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

B. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

C. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

D. Comply with NEMA PB 2.

E. Comply with NFPA 70.

F. Comply with UL 891.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Handle and prepare switchboards for installation according to NECA 400 and NEMA PB 2.1.

1.9 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR SWITCHBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D.
2. Cutler-Hammer.
3. General Electric.
4. Siemens.

B. Nominal System Voltage and Bus Ampacity Ratings: As indicated on Drawings..

C. Indoor Enclosures: Steel, NEMA 250, Type 1 , with manufacturer's standard gray finish factory applied over a rust-inhibiting primer on treated metal surface.

D. Outdoor Enclosures: Steel, NEMA 250 Type 3R with manufacturer's standard finish factory applied over a rust-inhibiting primer on treated metal surface..

1. Finish: Factory-applied finish in manufacturer's custom color; undersurfaces treated with corrosion-resistant undercoating.
2. Roof: Flat roof.

E. Structure and Enclosure Options:

1. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.
2. Barriers: Between adjacent switchboard sections.
3. Utility Metering Compartment: Fabricated, barrier compartment and section complying with utility company's requirements; hinged sealed door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard.

4. Bus Transition [and] Incoming Pull Sections: Matched and aligned with basic switchboard.
5. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
6. Pull Box on Top of Switchboard:

    a. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
    b. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
    c. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
    d. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

7. Barriers: Between adjacent switchboard sections.

F. Phase, Neutral, and Ground Buses: Three phase, four wire unless otherwise indicated. Fully-rated and uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends

1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity
2. Ground Bus: 1/4-by-2-inch- hard drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors.
3. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated.

G. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Aluminum.
2. Main and Neutral Lugs: Mechanical type.

See Editing Instruction No. 4 in the Evaluations for guidance on using compression versus mechanical lugs in first four subparagraphs below.

3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
4. Busway Feeders: Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run. Brace bus extensions for busway feeder neutral bus.

H. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

I. Switchboard Short-Circuit Current Rating: Panelboard and branch overcurrent protection fully rated to interrupt symmetrical short-circuit current available at terminals

2.2 FRONT-CONNECTED, FRONT-ACCESSIBLE SWITCHBOARDS

A. Main Devices: Fixed, individually mounted.

B. Branch Devices: Group mounted and fixed individual mounted.

C. Sections rear aligned.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489. Standard frame sizes, trip ratings, and number of poles. Mechanical style, suitable for number, size, trip ratings, and conductor materials.

1. Thermal-Magnetic: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip: With rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
    d. Ground-fault pickup level, time delay, and I2t response.

4. Current-Limiting: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. Integrally Fused: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
6. Ground-fault circuit interrupter (GFCI): Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
7. Ground-Fault Equipment Protection (GFEP): Class B ground-fault protection (30-mA trip).
8. Optional Features and Accessories, as indicated on Drawings:
    a. Lugs: Compression style, suitable for number, size, trip ratings, and conductor material.
    b. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    c. 100-Percent Rated: Provide breaker listed for 100 percent of the rated ampacity.

2.4 SURGE PROTECTIVE DEVICES

A. Surge Protective Devices : Factory installed as an integral part of switchboard, complying with UL 1449 SPD Type 2. Includes circuit breaker disconnect, LED indicator lights for power and protection status, EMI/RFI filtering, surge counter, internal thermal protection that disconnects the SPD before damaging internal suppressor components; 20kA nominal discharge current; 200 kA minimum short-circuit current rating.

1. Dry Contacts: Include Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status.
2. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than the values below. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

    a. Service Entrance: 240 kA.
    b. Distribution Panels: 160 kA.

3. Protection modes for circuits shall not exceed the following:

a. Line to Neutral: 1200 V for 480Y/277 V 700 V for 208Y/120 V.
b. Line or Neutral to Ground: 1200 V for 480Y/277 V 700 V for 208Y/120 V.
c. Line to Line: 2000 V for 480Y/277 V 1200 V for 208Y/120 V.

2.5 CONTROL POWER

A. Control Circuits: 24-V dc , supplied through secondary disconnecting devices from control-power transformer from remote branch circuit.

B. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.6 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

PART 3 EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NECA 400.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install switchboards and accessories according to NECA 400 and .

B. Equipment Mounting: Install switchboards on concrete base, comply with requirements for concrete base specified in Section 260529 ÓHangers and Supports for Electrical Systems.•

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Provide metal frame with clear acrylic plastic cover, mount on front of switchboards.

F. Install filler plates in unused spaces of panel-mounted sections.

G. Install overcurrent protective devices and components not already factory installed.

1. Set field-adjustable switches and circuit-breaker trip ranges.

3.3 CONNECTIONS

A. Arrange conductors in gutters into groups and bundle and wrap with wire ties. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.
b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
c. Instruments and Equipment:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Switchboard will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Overcurrent Protective Device Studies"

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories.

END OF SECTION 262413

SECTION 262416 - PANELBOARDS

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 panelboards rated 600V or less.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. ECB: Electronically-operated circuit breaker.

C. GFCI: Ground-fault circuit-interrupter.

D. GFEP: Ground-fault equipment protection.

E. SPD: Surge protective device.

1.4 ACTION SUBMITTALS

A. Provide the following in one comprehensive submittal:

1. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
2. Shop Drawings: For each panelboard and related equipment.

    a. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
    b. Detail enclosure types and details for types other than NEMA 250, Type 1.
    c. Detail bus configuration, current, and voltage ratings.
    d. Short-circuit current rating of panelboards and overcurrent protective devices.
    e. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
    f. Include wiring diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

C. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI, Types: Two spares for each panelboard.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Comply with NEMA PB 1.

D. Comply with NFPA 70.

E. Comply with UL 67.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle and prepare panelboards for installation according to NECA 407 and NEMA PB 1.

1.10 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cutler-Hammer.
2. General Electric.
3. Siemens.
4. Square D.

B. Enclosures: Flush- or surface-mounted cabinets, as indicated on Drawings. Galvanized steel back box.

1. NEMA 250 rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: Type 1.
b. Outdoor Locations: Type 3R.
c. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

2. Front: Entire trim hinged to box, door-in-door within hinged trim cover. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Steel with manufacturer¢s standard finish and coating, unless noted otherwise.
3. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
4. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
5. Doors: Concealed hinges; secured with vault-type or flush latch with tumbler lock; keyed alike. For doors more than 36 inches high, provide two latches.
6. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.

C. Incoming Mains Location: Top or bottom, as required.

D. Phase, Neutral, and Ground Buses:

1. Material: Tin-plated copper.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.

E. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Copper.
2. Main and Neutral Lugs: Mechanical type.
3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
6. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

G. Future Devices: Mounting brackets, fully-bussed connections, filler plates, and necessary appurtenances required for future installation of devices.

H. Panelboard Short-Circuit Current Rating: Panelboard and branch overcurrent protection fully rated to interrupt symmetrical short-circuit current available at terminals.

I. Contactors in Main Bus: NEMA ICS 2, Class A, electrically held, general-purpose controller, with same short-circuit interrupting rating as panelboard. Power source from Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.

2.2 DISTRIBUTION PANELBOARDS

A. Panelboards: NEMA PB 1, power and feeder distribution type.

B. Mains: Circuit breaker or lugs only As indicated on drawings.

C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers or; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

B. Mains: Circuit breaker or lugs only s indicated on Drawings.

C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

D. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489. Standard frame sizes, trip ratings, and number of poles. Mechanical style, suitable for number, size, trip ratings, and conductor materials. Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.

1. Thermal-Magnetic: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip: With rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
    d. Ground-fault pickup level, time delay, and I2t response.

4. Current-Limiting: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
6. GFEP: Class B ground-fault protection (30-mA trip).
7. Arc-Fault Circuit Interrupter (AFCI): Comply with UL 1699; 120/240-V, single-pole configuration.

2.5 SURGE PROTECTIVE DEVICES

A. Surge Protective Devices: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 2. Includes circuit breaker disconnect, LED indicator lights for power and protection status, EMI/RFI filtering, surge counter, internal thermal protection that disconnects the SPD before damaging internal suppressor components; 20kA nominal discharge current; 200 kA minimum short-circuit current rating.

1. Dry Contacts: Include Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status.
2. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than the values below. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

    a. Service Entrance: 240 kA.
    b. Distribution Panels: 160 kA.
    c. Branch Panels: 120 kA.

3. Protection modes for circuits shall not exceed the following:

    a. Line to Neutral: 1200 V for 480Y/277 V 700 V for 208Y/120 V.
    b. Line or Neutral to Ground: 1200 V for 480Y/277 V 700 V for 208Y/120 V.
    c. Line to Line: 2000 V for 480Y/277 V 1200 V for 208Y/120 V.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

B. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install panelboards and accessories according to NECA 407 and NEMA PB 1.1.

B. Floor-Mounted Panelboards: Install panelboards on concrete bases, comply with requirements for concrete base specified in Section 260529 ÓHangers and Supports for Electrical Systems.• Attach panelboard to the vertical finished or structural surface behind the panelboard.

C. Wall-Mounted Panelboards: Mount top of trim 90 inches above finished floor unless otherwise indicated. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

E. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

F. Install overcurrent protective devices and components not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

G. Install filler plates in unused spaces.

H. Recessed Panelboards: Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future.

3.3 WIRING INSTALLATION

A. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Distribution Panelboard Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Perform the following tests and inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
c. Instruments and Equipment:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain control modules.

3.7 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Studies."

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.8 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262416

SECTION 262713 - ELECTRICITY METERING

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 electricity metering work to accommodate utility company revenue meters, and Owner's electricity meters used to manage the electrical power system.

B. Section Includes: The work specified in this Section includes, but shall not be limited to, the following:

1. Furnish and install a complete metering system as detailed on the Drawings and as described in this Section. The system shall be designed to include remote devices for sub-metering, communication interface hardware, inter-communication wiring, personal computer workstation, software, printer, etc., where specified.
2. The metering system shall utilize Ethernet as the high speed backbone network that shall support connection of computing equipment with the metering devices connected to the network.

3. System software shall be provided as described in Part 2 - Products of this Section.

1.3 DEFINITIONS

A. KY or KYZ Pulse: Term used by the metering industry to describe a method of measuring consumption of electricity (kWh) that is based on a relay opening and closing in response to the rotation of the disk in the meter. Electronic meters generate pulses electronically.

1.4 ACTION SUBMITTALS

A. Provide the following in one comprehensive submittal:

1. Product Data: For each type of product indicated.
2. Shop Drawings: For electricity-metering equipment.

    a. Include elevation views of front panels of control and indicating devices and control stations.
    b. Include diagrams for power, signal, and control wiring.
    c. Wire Termination Diagrams and Schedules: Include diagrams for power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.

d. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices used. Describe characteristics of network and other data communication lines.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Application and operating software documentation.
2. Software licenses.
3. Software service agreement.
4. Device address list.
5. Hard copies of manufacturer's operating specifications, user's guides for software and hardware, and PDF files on a USB storage device of hard-copy Submittal.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of metering equipment that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Damage from transient voltage surges.

2. Warranty Period: Cost to repair or replace any parts for two years from date of Substantial Completion.

1.8 COORDINATION

A. Electrical Service Connections:

1. Coordinate with utility companies and utility-furnished components.

a. Comply with requirements of utility providing electrical power services.
b. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

1.9 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade his computer equipment if necessary.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

A. 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.

B. Comply with UL 916.

2.2 UTILITY METERING INFRASTRUCTURE

A. Install metering accessories furnished by the utility company, complying with its requirements.

B. Utility-Furnished Meters: Connect data transmission facility of metering equipment installed by the Utility.

C. Current-Transformer Cabinets: Comply with requirements of electrical-power utility company.

D. Meter Sockets:

1. Comply with requirements of electrical-power utility company.
2. Meter Sockets: Steady-state and short-circuit current ratings shall meet indicated circuit ratings.

2.3 ELECTRICITY METERS

A. System Description: Able to meter designated activity loads, with or without external alarm, control, and communication capabilities, or other optional features.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton.
2. General Electric Company.
3. Leviton Manufacturing Co., Inc.
4. SIEMENS Industry, Inc.; Energy Management Division.
5. Square D; by Schneider Electric.

C. Comply with ANSI C12.1 and ANSI C12.20, 0.5 accuracy class.

D. Capacities and Characteristics:

1. Measure: kWh, onboard LED display.
2. Remote-Reading Options: BACNet.

E. General Requirements for Meters:

1. Billing Meters Accuracy: 0.2 percent of reading, complying with ANSI C12.20.
2. Meters shall be certified by local agency as complying with local regulatory requirements.
3. Enclosure: Supplied by meter manufacturer, NEMA 250, Type 1 minimum, with provisions for locking or sealing.
4. Identification: Comply with requirements in Section 260553 "Identification for Electrical Systems."
5. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.
6. Sensors: Current-sensing type, supplied by electronic meter manufacturer, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.

    a. Type: solid core, complying with recommendation of meter manufacturer.

7. Current-Transformer Cabinet: Listed or recommended by metering equipment manufacturer for use with sensors indicated.
8. Building Automation System (BAS) Interface: One digital KY pulse to a user-definable increment of energy measurement. Match signal to BAS input and arrange to convey the instantaneous, integrated, demand level measured by meter to provide data for processing and possible programmed demand control action by destination system.

F. kWh Meter: Electronic single-phase and three-phase meters, measuring electricity use.

1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: LCD with characters not less than 0.25 inch high, indicating accumulative kWh and current kilowatt load. Retain accumulated kWh in a nonvolatile memory, until reset.

G. kWhd Meter: Electronic single-phase and three-phase meters, measuring electricity use and demand. Demand shall be integrated over a 15-minute interval.

1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: LCD with characters not less than 0.25 inch high, indicating the following:

    a. Accumulative kWh.
    b. Current time and date.
    c. Current demand.
    d. Historic peak demand.
    e. Time and date of historic peak demand.

3. Retain accumulated kWh and historic peak demand in a nonvolatile memory, until reset.

H. All metering shall be compatible as part of a single centralized energy monitoring system.

I. Communications

1. The power meter shall communicate via serial RS-485 Modbus or Jbus protocol.

2. The power meter shall provide Ethernet communications using Modbus TCP at 10/100Mbaud using UTP.
3. The power meter shall provide two Ethernet ports to allow wiring from meter to meter as a daisy-chain.
4. The power meter shall natively support BACnet/IP protocol and have the capability to directly communicate with BACnet/IP networks.
5. The power meter shall have the capability to communicate via Modbus TCP/IP and BACnet/IP simultaneously.
6. The power meter shall be tested and approved by BACnet Testing Laboratories (BTL) as a BACnet Application Specific Controller (B-ASC).
7. The power meter shall have the capability to serve data over the Ethernet network accessible through a standard web browser. The power meter shall contain default pages from the factory. The power meter shall push logging information through Ethernet communication port.
8. The power meter shall have integrated gateway functionality, enabling the capability to connect via Ethernet to downstream, serially-connected devices.
9. The power meter gateway shall have the capability to limit host meter and serial slave device access with Modbus TCP/IP filtering.
10. The power meter shall have the capability to manage and monitor devices on the IP network via Simple Network Management Protocol [SNMP].
11. The power meter shall have the capability to compose and send emails and/or text messages containing alarm condition indication via Simple Mail Transfer Protocol [SMTP].
12. The power meter shall have the capability to synchronize with a known addressable time reference via Simple Network Time Protocol [SNTP].

J. Software: PC based and web enabled energy management system, a product recommended by meter manufacturer, suitable for monitoring and tracking utility cost allocation.

1. Monitoring, recording and reporting: Automatically import electricity-usage records to allocate electricity costs for the following:

a. Total electrical energy, HVAC systems, interior lighting, and receptacle circuits in compliance with ASHRAE 90.1 2016.

b. Areas as as directed by the Owner .
c. Specified loads as directed by the Owner.

PART 3 EXECUTION

3.1 INSTALLATION

A. Comply with equipment installation requirements in NECA 1.

B. Install meters furnished by utility company. Install raceways and equipment according to utility company's written instructions. Provide empty conduits for metering leads and extend grounding connections as required by utility company.

C. Install modular meter center according to switchboard installation requirements in NECA 400.

D. Install arc-flash labels as required by NFPA 70.

E. Wiring Method:

1. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
2. Install unshielded, twisted-pair cable for control and signal transmission conductors, complying with Section 271513 "Communications Copper Horizontal Cabling."
3. Minimum conduit size shall be 1/2 inch.

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections with the assistance of a factory-authorized service representative.

C. Tests and Inspections:

1. Equipment and Software Setup:

a. Set meter date and time clock.
b. Test, calibrate, and connect pulse metering system.
c. Set and verify billing demand interval for demand meters.
d. Report settings and calibration results.
e. Set up reporting and billing software, insert billing location names and initial constant values and variable needed for billing computations.

2. Connect a load of known kilowatt rating, 1.5 kW minimum, to a circuit supplied by metered feeder.
3. Turn off circuits supplied by metered feeder and secure them in off condition.
4. Run test load continuously for eight hours minimum, or longer, to obtain a measurable meter indication. Use test-load placement and setting that ensures continuous, safe operation.
5. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results.
6. Generate test report and billing for each tenant or activity from the meter reading tests.

D. Electricity metering will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.3 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's clerical and maintenance personnel to use, adjust, operate, and maintain the electronic metering and billing software.

END OF SECTION 262713

SECTION 262726 - WIRING DEVICES

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 receptacles, switches, and other wiring devices.

B. Related Requirements:

1. Section 260533 Raceways And Boxes For Electrical Systems• for floor boxes.
2. Section 260923 "Lighting Control Devices" for wall mounted occupancy sensors and low voltage control switches.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. SPD: Surge protective device.

F. USB: Universal serial bus.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Samples: One for each type of device and wall plate specified, in each color specified.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

1.7 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

B. Comply with NFPA 70.

C. Comply with UL 2459 for modular plug-in connectors.

D. Comply with NEMA WD 1.

E. Comply with NEMA WD 6 and UL 498 for receptacles.

F. Comply with UL 943 for GFCI receptacles.

G. Comply with UL 1449 for SPD receptacles.

H. Comply with UL 20 for switches.

I. Comply with UL 1472 for wall-box dimmers.

J. Comply with UL 1917 for fan speed controls.

K. Comply with NEMA FB 11 and UL 1010 for hazardous (classified) location receptacles.

L. Comply with UL 514 for poke-through assemblies.

1.8 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

B. Cord and Plug Sets: Match equipment requirements.

C. Coordinate final location of furniture and poke-through assemblies, with Architect.

PART 2 PRODUCTS

2.1 STANDARD WIRING DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Cooper Wiring Devices.

2. Hubbell Wiring Device-Kellems.
3. Leviton.
4. Pass & Seymour.

B. Decorator-Style Devices: Unless noted otherwise or unavailable for an option, provide wiring devices with rectilinear, decorator-style faces.

C. Modular Plug-In Connectors: Devices that are manufactured to utilize modular plug-in connectors with stranded building wire pigtail may be substituted.

D. Straight-Blade Receptacles: Specification-grade, heavy-duty, 125 V, 20 A, NEMA 5-20R, grounding type, back or side wired. Provide single or duplex, with types, or combinations thereof, as indicated on Drawings.

1. GFCI: Personnel protection, feed -through, with indicator light for protection status.
2. Isolated-Ground: Grounding screw terminal electrically isolated from mounting strap for equipment ground connections.
3. Tamper-Resistant: Integral dual mechanical shutter system to help prevent insertion of foreign objects.
4. Weather-Resistant: With additional protection against accelerated aging, cold impact, corrosion, and ultraviolet light exposure.
5. SPD: Type 3, with integral multiple metal-oxide varistors in line-to-ground, line-to-neutral, and neutral-to-ground; nominal clamp-level rating of 400 V and minimum single transient pulse energy dissipation of 240 J; EMI/RFI suppression filters; active visual and audible indicators in face of device to indicate device is "active" or "no longer in service."
6. USB: Combination device with two internally powered USB ports, compatible with USB 2.0 and 3.0 devices.
7. Illuminated: Integral lamp within the face of the receptacle is lighted when connected to an energized circuit.
8. Clock: Recessed simplex receptacle with integral faceplate.

E. Specialty Receptacles: Specification-grade, extra heavy-duty, grounding type. Provide voltages, ampacities, and NEMA configurations as indicated on Drawings.

F. Locking-Blade Receptacles: Industrial-grade, heavy-duty, twist to lock, grounding type, back or side wired. Provide types, or combinations thereof, as indicated on Drawings.

1. Isolated-Ground: Grounding screw terminal electrically isolated from mounting strap for equipment ground connections.

G. Switches: Specification-grade, heavy-duty, 120/277 V, 20 A, quiet-type, grounding type, back and side wired. Provide number of poles, number of ways, and types, or combinations thereof, as indicated on Drawings.

1. Toggle: Snap-style switch handle.
2. Three-Position Switches: Single-pole, double-throw, momentary contact, center-off switches for use with mechanically held lighting contactors.

H. Wall Plates: Standard-size single and combination types to match corresponding wiring devices. Plate-securing metal screws with head color matching plate finish.

1. Finished Spaces: Material and color as selected by Architect .
2. Unfinished Spaces: Galvanized steel.
3. Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
4. Wet-Locations: Raintight, weather-resistant in-use cover plates, complying with : NEMA 250 Type 3R, die-cast aluminum with lockable cover and openings for cords.

I. Device Color Finishes:

1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.

2. Wiring Devices Connected to Emergency Power System: Red.
3. Isolated-Ground Receptacles: Orange.

2.2 HAZARDOUS (CLASSIFIED) LOCATION DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following

1. Appleton Electric.
2. Cooper Crouse-Hinds.
3. Killark.

B. Single Receptacles: Listed for Classification and Group as indicated on Drawings, 125 V, 20 A, energized by matching twist-locking type plug, spring-loaded cover.

2.3 CORD AND PLUG SETS

A. Cord and Plug Sets: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

1. Cord: Rubber-insulated, stranded-copper conductors, with Type SO jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
2. Plug: Nylon body and integral cable-clamping jaws. Match receptacle type for connection.

2.4 CORD REELS

A. Description: Industrial ceiling mounted retractable power cord reel

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following

1. Reelcraft.
2. Conductix.
3. Hubbell Incorporated; Wiring Device-Kellems.

4. Wiremold / Legrand.

C. Construction:

1. Steel frame construction
2. Powder-coat finish
3. Heavy duty for industrial indoor applications.

D. Mounting: stationary, ceiling mounted on steel support system for reel spring retractble pull-down operation. Refer to Section 260529 "Hangers and Supports for Electrical Systems" for electrical supports and installation requirements.

E. Listing: UL Listed for selected application.

F. Reel and Cable Assembly:

1. Cable: type SO, min. 120V up to 600V as indicated on drawings, custom cable rating as indicated on drawings
2. Cord Option: flying lead with receptacles boxes and single NEMA receptacle configurations as indicated on drawings.
3. Length: 25 feet.
4. 6 foot feeder cord with NEMA 5-20P plug to transfer power to the reel.
5. Adjustable ball stop
6. Safety chain hole

PART 3 EXECUTION

3.1 INSTALLATION

A. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

B. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
3. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

C. Wiring Installation:

1. Connect devices to branch circuits , comply with requirements in Section 260519 Low-Voltage Electrical Power Conductors And Cables.•

2. When there is a choice, use side wiring with binding-head screw terminals. Wrap conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
3. Use a torque screwdriver when a torque is recommended or required by manufacturer.
4. Tighten unused terminal screws on the device.

D. Receptacle Orientation: Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the left.

E. GFCI Receptacles: Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

F. Device Plates: Group adjacent devices under single, multigang wall plates. Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Do not exceed manufacturer recommended mounting heights for cable reels.

3.2 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number.

C. FIELD QUALITY CONTROL

D. Perform the following tests and inspections:

1. Test Instrument for Convenience Receptacles: Use digital wiring analyzer that complies with UL 1436, with digital readout or illuminated digital-display indicators of measurement.

E. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

F. Wiring device will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

3.3 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems".

B. Identify each receptacle and cord reel with panelboard identification and circuit number. Use self-adhesive labels with 1/2-inch high black letters on white background on revserse side of receptacle faceplate and durable wire markers or tags inside outlets boxes.

END OF SECTION 262726

SECTION 262813 - FUSES

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:

1. Low-voltage cartridge fuses rated 600volts AC and less
2. Medium-voltage barrel fuses rated over 600 volts AC.
3. Spare-fuse cabinets.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. 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. Coordination charts and tables and related data.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:

1. Ambient temperature adjustment information.
2. Current-limitation curves for fuses with current-limiting characteristics.
3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
4. Coordination charts and tables and related data.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

B. Comply with NEMA FU 1 for cartridge fuses.

C. Comply with NFPA 70.

1.7 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.8 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following :

1. Cooper Bussmann.
2. Littelfuse.
3. Mersen.

2.2 CARTRIDGE FUSES RATED 600V OR LESS

A. Characteristics: Nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages. Refer to Drawings for ratings.

1. 601 Ampere or Larger: Class L, fast acting.
2. 600 Ampere or Less:

a. Feeder and Branch Circuit Protection: Class J, time delay.
b. Motor Circuit Protection: Class RK5, time delay.
c. Control Circuits: Class CC, time delay.

2.3 BARREL FUSES RATED OVER 600 VOLTS

A. Characteristics: Nonrenewable barrel fuses with voltage ratings consistent with circuit voltages. Refer to drawings for ratings.

1. Transformer and Feeder Protection: E-Rated, current limiting.
2. Motor Circuit Protection: R-Rated, current limiting.

2.4 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted 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 with 15 percent spare capacity minimum.
2. Finish: Gray, baked enamel.
3. Identification: "SPARE FUSES" in 1-1/2-inch- high letters on exterior of door.
4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare-fuse cabinet(s).

3.3 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

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 enclosed switches , and elevator shunt trip switches..

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

A. Provide the following in one comprehensive submittal:

1. Product Data: For each type of enclosed switch, elevator shunt trip switch, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

    a. Enclosure types and details for types other than NEMA 250, Type 1.
    b. Current and voltage ratings.
    c. Short-circuit current ratings (interrupting and withstand, as appropriate).

    d. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
    e. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

2. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

    a. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Field quality-control reports.

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain enclosed switches, components, and accessories, within same product category, from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Comply with NFPA 70.

E. Comply with UL 98 and NEMA KS 1 for enclosed switches.

F. Comply with ASME A17.1, UL 50, and UL 98 for elevator shunt trip switches.

G. Comply with Comply with UL 489, NEMA AB 1, and NEMA AB 3 for molded-case circuit breakers.

1.8 COORDINATION

A. Coordinate layout and installation of switches, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 PRODUCTS

2.1 ENCLOSED SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cutler-Hammer.
2. General Electric.
3. Siemens.
4. Square D.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: Horsepower rated,, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

1. Fusible Switch: Include clips or bolt pads to accommodate specified fuses.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
4. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Mechanical type, suitable for number, size, and conductor material.
7. Service-Rated Switches: Labeled for use as service equipment.

2.2 ELEVATOR SHUNT TRIP SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Bussmann.
2. Littelfuse.
3. Mersen.

B. Elevator Shunt Trip Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

C. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power source of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.

D. Accessories:

1. Oiltight key switch for key-to-test function.
2. Oiltight red ON pilot light.
3. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
4. Form C alarm contacts that change state when switch is tripped.
5. Three-pole, double-throw, fire-safety and alarm relay; 120-V ac coil voltage.
6. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

2.3 ENCLOSURES

A. Enclosures: NEMA 250, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: Type 1.
2. Outdoor Locations: Type 3R.
3. Wash-Down Areas: Type 4X, stainless steel.
4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.
5. Hazardous Areas Indicated on Drawings: [.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

3.3 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch 11 months after date of Substantial Completion.
    c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

C. Enclosed switches will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Studies."

END OF SECTION 262816

SECTION 262913 - ENCLOSED CONTROLLERS

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 the enclosed controllers rated 600 V and less.

1.3 DEFINITIONS

A. CPT: Control power transformer.

B. MCCB: Molded-case circuit breaker.

C. MCP: Motor circuit protector.

D. N.C.: Normally closed.

E. N.O.: Normally open.

F. OCPD: Overcurrent protective device.

1.4 ACTION SUBMITTALS

A. Provide the following in one comprehensive submittal:

1. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.
2. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.

    a. Show tabulations of the following:

        1) Each installed unit's type and details.
        2) Factory-installed devices.
        3) Nameplate legends.
        4) Short-circuit current rating of integrated unit.
        5) Retain first subparagraph below if series rating of OCPDs is used or if combination controllers are specified.
        6) Listed and labeled for integrated short-circuit current (withstand) rating of OCPDs in combination controllers by an NRTL acceptable to authorities having jurisdiction.

7) Retain first subparagraph below if combination controllers are specified.
8) Features, characteristics, ratings, and factory settings of individual OCPDs in combination controllers.

b. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Field quality-control reports.

C. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

D. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for enclosed controllers and installed components.
2. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
3. Manufacturer's written instructions for setting field-adjustable overload relays.

1.7 MATERIALS MAINTENANCE SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Indicating Lights: Two of each type and color installed.
2. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
3. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Comply with NFPA 70.

C. Comply with NEMA ICS 2, general purpose, Class A.

1.9 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Match overload relays to nameplate full-load current of actual protected motor.

1. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Allen-Bradley.
2. Cutler-Hammer.
3. General Electric.
4. Siemens.
5. Square D.

2.2 MANUAL CONTROLLERS

A. Horsepower-Rated Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

1. Configuration: Nonreversing.
2. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; external reset push button; bimetallic type.
3. Surface mounting.
4. Red pilot light.

2.3 MAGNETIC CONTROLLERS

A. Magnetic Controllers: Full voltage, across the line, electrically held.

1. Configuration: Nonreversing.
2. Contactor Coils: Pressure-encapsulated type with coil transient suppressors. Operating voltage to match control power.
3. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
4. Control Circuits: 24 -V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices and with 50 VA of spare capacity.

5. Overload Relays: Include N.C. isolated overload alarm contact and external overload reset push button.

    a. Melting Alloy Type: Inverse-time-characterstic, Class 10 tripping characteristic, with heaters in each phase with appropriate adjustment for duty cycle.
    b. Bimetallic Type: Inverse-time-current characteristic, ambient compensated, automatic resetting, Class 10 tripping characteristic, with heaters in each phase with appropriate adjustment for duty cycle.
    c. Solid-State Type: Switch or dial selectable for motor running overload protection, sensors in each phase, Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
        1) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
        2) Analog communication module.

B. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means with lockable handle that accepts three padlocks and interlocks with cover in closed position.

1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate specified fuses.

C. Accessories:

General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

1. Push Buttons, Pilot Lights, and Selector Switches: Heavy -duty, type.

    a. Push Buttons: Lockable types; maintained as indicated.
    b. Pilot Lights: LED types; colors as indicated; push to test.
    c. Selector Switches: Rotary type.

2. Reversible N.C./N.O. auxiliary contact(s).
3. Time-Delay Relays: Auxiliary and adjustable solid-state time-delay relays.
4. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
5. Terminals for connecting power factor correction capacitors to the line side of overload relays.
6. Spare control wiring terminal blocks, quantity as indicated; unwired.

2.4 ENCLOSURES

A. Enclosures: NEMA 250, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: Type 1.
2. Outdoor Locations: Type 3R.
3. Kitchen Wash-Down Areas: Type 4X, stainless steel.
4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

B. Enclosure Accessories:

1. Space heaters, with N.C. auxiliary contacts, to mitigate condensation in Type 3R enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
2. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.
3. Cover gaskets for Type 1 enclosures.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements and other conditions affecting performance of the Work.

B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

B. Floor-Mounted Controllers: Install enclosed controllers on concrete bases complying with requirements in Section 260529 Hangers and Supports for Electrical Systems.•

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in each fusible-switch enclosed controller.

E. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

F. Install power factor correction capacitors. Connect to the line side of overload relays. If connected to the load side of overload relays, adjust overload heater sizes to accommodate the reduced motor full-load currents.

3.3 IDENTIFICATION

A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers and remote devices. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control selection devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Tests and Inspections:

1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Construction Manager before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each multi-pole enclosed controller. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each multi-pole enclosed controller 11 months after date of Substantial Completion.
    c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

C. Enclosed controllers will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Set field-adjustable switches, relays, and overload-relay pickup and trip ranges.

B. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Construction Manager before increasing settings.

C. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Overcurrent Protective Device

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers.

END OF SECTION 262913

SECTION 263213.13 - DIESEL EMERGENCY ENGINE GENERATORS

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 packaged diesel engine generators for emergency use with the following features:

1. Diesel engine.
2. Diesel fuel-oil system.
3. Control and monitoring.
4. Generator overcurrent and fault protection.
5. Generator, exciter, and voltage regulator.
6. Load banks.
7. Outdoor engine generator enclosure.
8. Remote radiator motors.
9. Vibration isolation devices.
10. Finishes.

1.3 DEFINITIONS

A. EPS: Emergency power supply.

B. EPSS: Emergency power supply system.

C. Operational Bandwidth: The total variation, from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Include thermal damage curve for generator.
3. Include time-current characteristic curves for generator protective device.
4. Include fuel consumption in gallons per hour at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
5. Include generator efficiency at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.

6. Include airflow requirements for cooling and combustion air in cubic feet per minute at 0.8 power factor, with air-supply temperature of 95, 80, 70, and 50 deg F. Provide Drawings indicating requirements and limitations for location of air intake and exhausts.
7. Include generator characteristics, including, but not limited to, kilowatt rating, efficiency, reactances, and short-circuit current capability.

B. Shop Drawings:

1. Include plans and elevations for engine generator and other components specified. Indicate access requirements affected by height of subbase fuel tank.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Identify fluid drain ports and clearance requirements for proper fluid drain.
4. Design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and supported equipment. Include base weights.
6. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for EPS equipment and functional relationship between all electrical components.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Coordinate the required fuel oil piping connections, installation on structural steel supports or concrete bases, and interlocks with the Automatic Fuel Oil Transfer and Monitoring System. Provide plans, elevations, wiring diagrams and coordinate details of installation.

B. Seismic Qualification Data: Certificates for engine generator, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: With engine and generator mounted on rails, identify center of gravity and total weight, including full fuel tank, supplied enclosure, silencer, subbase-mounted fuel tank, and each piece of equipment not integral to the engine generator, and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

D. Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For engine generators to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
b. Operating instructions laminated and mounted adjacent to generator location.
c. Training plan.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.
4. Tools: Each tool listed by part number in operations and maintenance manual.

1.8 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Basis of Design: Kohler Power Systems, Division of Kohler Company

2. Caterpillar, Inc.; Electric Power Division.
3. Cummins Power Generation.

B. Source Limitations: Obtain packaged engine generators and auxiliary components from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Engine generator housing, subbase fuel tank, engine generator, batteries, battery racks, silencers, sound attenuating equipment, accessories, and components shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified. and the unit will be fully operational after
2. Component Importance Factor: 1.0.

B. B11 Compliance: Comply with B11.19.

C. NFPA Compliance:

1. Comply with NFPA 37.
2. Comply with NFPA 70.
3. Comply with NFPA 99.
4. Comply with NFPA 110 requirements for Level 1 EPSS.

D. UL Compliance: Comply with UL 2200.

E. Engine Exhaust Emissions: Comply with EPA Tier 2 requirements and applicable state and local government requirements.

F. Noise Emission: Comply with applicable state and local government requirementsfor maximum noise level at adjacent property boundaries due to sound emitted by engine generator, including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

G. Environmental Conditions: Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: 5 to 104 deg F.

2.3 ENGINE GENERATOR ASSEMBLY DESCRIPTION

A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.

B. 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.

C. EPSS Class: Engine generator shall be classified as a Class 2 according to NFPA 110.

D. Service Load: As indicated on drawings.

E. Power Factor: 0.8, lagging.

F. Frequency: 60 Hz

G. Voltage: 208 V ac.

H. Phase: Three-phase, four-wire .

I. Induction Method: Turbocharged and air-cooled.

J. Governor: Adjustable isochronous, with speed sensing.

K. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.

1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and engine generator center of gravity.

L. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated at 0.8 power factor excluding power required for the continued and repeated operation of the unit and auxiliaries.
2. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

M. Engine Generator Performance:

1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage, from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency, from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time: Comply with NFPA 110, Type 10 system requirements.

2.4 DIESEL ENGINE

A. Rated Engine Speed: 1800 rpm.

B. Lubrication System: Engine or skid mounted.

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

C. Jacket Coolant Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity and with UL 499.

D. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine generator mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
2. Size of Radiator: Adequate to contain expansion of total system coolant, from cold start to 110 percent load condition.
3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant-system pressure for engine used. Equip with gage glass and petcock.
4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, UV-, and abrasion-resistant fabric.

    a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and noncollapsible under vacuum.
    b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

E. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

1. Minimum sound attenuation of 25 dB at 500 Hz.
2. Sound level measured at a distance of 23 feet from exhaust discharge after installation is complete shall be 86 dBA or less.

F. Air-Intake Filter: Standard -duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

G. Starting System: 24 V electric, with negative ground.

1. Components: Sized so they are not damaged during a full engine-cranking cycle, with ambient temperature at maximum specified in "Performance Requirements" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: 10 seconds .
4. Battery: Lead acid, with capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least twice without recharging.
5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 50 deg F regardless of external ambient temperature within range specified in "Performance Requirements" Article. Include accessories required to support and fasten batteries in place. Provide ventilation to exhaust battery gases.
7. Battery Stand: Factory-fabricated, two-tier metal with acid-resistant finish designed to hold the quantity of battery cells required and to maintain the arrangement to minimize lengths of battery interconnections.
8. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.

9. Battery Charger: Current-limiting, automatic-equalizing, and float-charging type designed for lead-acid batteries. Unit shall comply with UL 1236 and include the following features:

    a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
    b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg F to 140 deg F to prevent overcharging at high temperatures and undercharging at low temperatures.
    c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
    d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
    e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
    f. Enclosure and Mounting: NEMA 250, Type 1 wall-mounted cabinet.

2.5 DIESEL FUEL-OIL SYSTEM

A. Comply with NFPA 30.

B. Piping:comply with requirements in Section 231113 "Facility Fuel-Oil Piping."

C. Main Fuel Pump: Mounted on engine to provide primary fuel flow under starting and load conditions.

D. Fuel Filtering: Remove water and contaminants larger than 1 micron.

E. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

F. Subbase-Mounted, Double-Wall, Fuel-Oil Tank: Factory installed and piped, complying with UL 142 fuel-oil tank. Features include the following:

1. Tank level indicator.
2. Fuel-Tank Capacity: As indicated on drawings.
3. Pump Capacity: Exceeds maximum flow of fuel drawn by engine-mounted fuel-supply pumps at 110 percent of rated capacity, including fuel returned from engine.
4. Low-Level Alarm Sensor: Liquid-level device operates alarm contacts at 25 percent of normal fuel level.
5. High-Level Alarm Sensor: Liquid=level device operates alarm and redundant fuel-shutoff contacts at midpoint between overflow level and 100 percent of normal fuel level.
6. Redundant High-Level Fuel Shutoff: Actuated by high-level alarm sensor in subbase tank to operate a separate motor control device that disconnects transfer-tank pump motor. Sensor shall signal solenoid valve, located in fuel sution line between subbase tank and transfer tank, to close. Both actions shall remain in shutoff state until manually reset. Shutoff action shall initiate an alarm signal to control panel but shall not shut down eingine generator.
7. Piping connections: Factory-sintalled fuel-supply and return lines, from tank to engine; local fuel fill; vent line; overflow line; and tank drain line with shutoff valve.

8. Leak detection in interstitial space.
9. Vandal-resistant fill cap.
10. Containment Provisions: Comply with New York State requirements.authorities having jurisdiction.

2.6 CONTROL AND MONITORING

A. Automatic-Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of engine generator. When mode-selector switch is switched to the on position, engine generator starts. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.

B. Provide minimum run time control set for 30 minutes, with override only by operation of a remote emergency-stop switch.

C. Comply with UL 508A.

D. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the engine generator. Mounting method shall isolate the control panel from engine generator vibration. Panel shall be powered from the engine generator battery.

E. Control and Monitoring Panel:

1. Digital controller with integrated LCD display, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.
2. Instruments: Located on the control and monitoring panel and viewable during operation.

    a. Engine lubricating-oil pressure gage.
    b. Engine-coolant temperature gage.
    c. DC voltmeter (alternator battery charging).
    d. Running-time meter.
    e. AC voltmeter, connected to a phase selector switch.
    f. AC ammeter, connected to a phase selector switch.
    g. AC frequency meter.
    h. Generator-voltage-adjusting rheostat.

3. Controls and Protective Devices: Controls, shutdown devices, and common visual alarm indication as required by NFPA 110 for Level 1 system, including the following:

    a. Cranking control equipment.
    b. Run-Off-Auto switch.
    c. Control switch not in automatic position alarm.
    d. Overcrank alarm.
    e. Overcrank shutdown device.
    f. Low water temperature alarm.
    g. High engine temperature pre-alarm.
    h. High engine temperature.
    i. High engine temperature shutdown device.
    j. Overspeed alarm.
    k. Overspeed shutdown device.

l. Low-fuel main tank.

1) Low-fuel-level alarm shall be initiated when the level falls below that required for operation for the duration required for the indicated EPSS class.

m. Coolant low-level alarm.
n. Coolant low-level shutdown device.
o. Coolant high-temperature prealarm.
p. Coolant high-temperature alarm.
q. Coolant low-temperature alarm.
r. Coolant high-temperature shutdown device.
s. EPS load indicator.
t. Battery high-voltage alarm.
u. Low-cranking voltage alarm.
v. Battery-charger malfunction alarm.
w. Battery low-voltage alarm.
x. Lamp test.
y. Contacts for local and remote common alarm.
z. Low-starting air pressure alarm.
aa. Low-starting hydraulic pressure alarm.
bb. Remote manual-stop shutdown device.
cc. Air shutdown damper alarm when used.
dd. Air shutdown damper shutdown device when used.
ee. Generator overcurrent-protective-device not-closed alarm.

F. Connection to Datalink:

1. A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication.
2. Provide connections for datalink transmission of indications to remote data terminals via ModBusand Ethernet. Data system connections to terminals are covered in Section 260913 "Electrical Power Monitoring and Control."

G. Common Remote Panel with Common Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel. Remote panel shall be powered from the engine generator battery.

H. Remote Alarm Annunciator: Comply with NFPA 99. An LED indicator light labeled with proper alarm conditions shall identify each alarm event, and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

1. Overcrank alarm.
2. Coolant low-temperature alarm.
3. High engine temperature prealarm.
4. High engine temperature alarm.
5. Low lube oil pressure alarm.
6. Overspeed alarm.
7. Low-fuel main tank alarm.
8. Low coolant level alarm.
9. Low-cranking voltage alarm.
10. Contacts for local and remote common alarm.
11. Audible-alarm silencing switch.

12. Air shutdown damper when used.
13. Run-Off-Auto switch.
14. Control switch not in automatic position alarm.
15. Fuel tank derangement alarm.
16. Fuel tank high-level shutdown of fuel-supply alarm.
17. Lamp test.
18. Low-cranking voltage alarm.
19. Generator overcurrent protective device not closed.

I. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator unless otherwise indicated.

J. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.7 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.

1. Overcurrent protective devices for the EPSS shall be accessible only to authorized personnel.

B. Generator Circuit Breaker: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.

1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
2. Trip Settings: Selected to coordinate with generator thermal damage curve.
3. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.
4. Mounting: Adjacent to or integrated with control and monitoring panel.

C. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other engine generator protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector performs the following functions:

1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other engine generator malfunction alarms. Contacts shall be available for load shed functions.
2. Under single- or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the engine generator.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

D. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground fault.

1. Indicate ground fault with other engine generator alarm indications.
2. Trip generator protective device on ground fault.

2.8 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H or Class F.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required. Provide six 12-lead alternator.

E. Range: Provide broad range of output voltage by adjusting the excitation level.

F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

G. Enclosure: Dripproof.

H. Instrument Transformers: Mounted within generator enclosure.

I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified and as required by NFPA 110.

1. Adjusting Rheostat on Control and Monitoring Panel: Provide plus or minus 10 percent adjustment of output-voltage operating band.
2. Maintain voltage within 20 percent on one step, full load.
3. Provide anti-hunt provision to stabilize voltage.
4. Maintain frequency within 10 percent and stabilize at rated frequency within two seconds.

J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

K. Subtransient Reactance: 15 percent, maximum.

2.9 OUTDOOR ENGINE GENERATOR ENCLOSURE

A. Description: Vandal-resistant, sound-attenuating, weatherproof steel housing, wind resistant up to 100 mph. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

1. Sound Attenuation Level: 86 dBA at 23 ft..

B. Description: Prefabricated or pre-engineered, galvanized-steel-clad, integral structural-steel-framed, skin-tight enclosure.

C. Structural Design and Anchorage: Comply with ASCE/SEI 7 for wind loads of up to 150 mph.

D. Seismic Design: Comply with seismic requirements in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Hinged Doors: With padlocking provisions.

F. Jacket Heater: Thermostatically controlled and sized to prevent condensation.

G. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with jacket heater to maintain winter interior temperature within operating limits required by engine generator components.

H. Muffler Location: Within enclosure.

I. Engine-Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for two hours with ambient temperature at top of range specified in system service conditions.

1. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

J. Interior Lights with Switch: Factory-wired, vapor-proof luminaires within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.

1. AC lighting system and connection point for operation when remote source is available.

K. Convenience Outlets: Factory-wired GFCI. Arrange for external electrical connection.

2.10 VIBRATION ISOLATION DEVICES

A. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.

1. Housing: Steel with resilient, vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment-mounting and -leveling bolt that acts as blocking during installation.
2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Minimum Deflection: 1 inch.

B. Comply with requirements in Section 232116 "Hydronic Piping Specialties" for vibration isolation and flexible connector materials for steel piping.

C. Vibration isolation devices shall not be used to accommodate misalignments or to make bends.

2.11 FINISHES

A. Indoor and Outdoor Enclosures and Components: Custom finish over corrosion-resistant pretreatment and compatible primer.

2.12 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine generator using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

B. Project-Specific Equipment Tests: Before shipment, factory test engine generator and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
2. Test generator, exciter, and voltage regulator as a unit.
3. Full-load run.
4. Maximum power.
5. Voltage regulation.
6. Transient and steady-state governing.
7. Single-step load pickup.
8. Safety shutdown.
9. Report factory test results within 10 days of completion of test.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine generator performance.

B. Examine roughing-in for piping systems and electrical connections. Verify actual locations of connections before packaged engine generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Construction Manager no fewer than 14 working days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

3.3 INSTALLATION

A. Comply with NECA 1 and NECA 404.

B. Comply with packaged engine generator manufacturers' written installation and alignment instructions and with NFPA 110.

C. Equipment Mounting:

1. Install packaged engine generators on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Coordinate size and location of concrete bases for packaged engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
3. Install packaged engine generator in skin-tight enclosure with restrained spring isolators having a minimum deflection of 1 inch on structural support indicated on drawings. Secure enclosure to anchor bolts installed on steel dunnage.
4.

a.
b.

D. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

E. Drain Piping: Install condensate drain piping to muffler drain outlet with a shutoff valve, stainless-steel flexible connector, and Schedule 40 black steel pipe with welded joints.

1. Piping materials and installation requirements are specified in Section 232113 "Hydronic Piping."
2. Drain piping valves, connectors, and installation requirements are specified in Section 232116 "Hydronic Piping Specialties."

F. Fuel Piping:

1. Diesel storage tanks, tank accessories, piping, valves, and specialties for fuel systems are specified in Section 231113 "Facility Fuel-Oil Piping."

G. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.

B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow space for service and maintenance.

C. Connect engine exhaust pipe to engine with flexible connector.

D. Connect fuel piping to engines with a gate valve and union and flexible connector.

1. Additional requirements for diesel storage tanks, tank accessories, piping, valves, and specialties for fuel systems are specified in Section 231113 "Facility Fuel-Oil Piping."

E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Provide a minimum of one 90-degree bend in flexible conduit routed to the engine generator from a stationary element.

G. Balance single-phase loads to obtain a maximum of 10 percent unbalance between any two phases.

3.5 IDENTIFICATION

A. Identify system components according to Section 230553 "Identification for HVAC Piping and Equipment" and Section 260553 "Identification for Electrical Systems."

B. Install a sign indicating the generator neutral is bonded to the main service neutral at the main service location.

3.6 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Perform tests recommended by manufacturer and in "Visual and Mechanical Inspection" and "Electrical and Mechanical Tests" subparagraphs below, as specified in the NETA ATS. Certify compliance with test parameters.

    a. Visual and Mechanical Inspection:

        1) Compare equipment nameplate data with Drawings and the Specifications.
        2) Inspect physical and mechanical condition.
        3) Inspect anchorage, alignment, and grounding.
        4) Verify that the unit is clean.

    b. Electrical and Mechanical Tests:

        1) Perform insulation-resistance tests according to IEEE 43.

            a) Machines Larger Than 200 hp: Test duration shall be 10 minutes. Calculate polarization index.
            b) Machines 200 hp or Less: Test duration shall be one minute. Calculate the dielectric-absorption ratio.

        2) Test protective relay devices.
        3) Verify phase rotation, phasing, and synchronized operation as required by the application.
        4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
        5) Perform vibration test for each main bearing cap.
        6) Conduct performance test according to NFPA 110.
        7) Verify correct functioning of the governor and regulator.

2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here, including, but not limited to, single-step full-load pickup test.
3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

    a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
    b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
    c. Verify acceptance of charge for each element of the battery after discharge.
    d. Verify that measurements are within manufacturer's specifications.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.
6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
7. Exhaust Emissions Test: Comply with applicable government test criteria.
8. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
9. Harmonic-Content Tests: Measure harmonic content of output voltage at 25 percent and 100 percent of rated linear load. Verify that harmonic content is within specified limits.
10. Noise-Level Tests: Measure A-weighted level of noise emanating from engine generator installation, including engine exhaust and cooling-air intake and discharge, at four locations 23 feet from edge of the generator enclosure and on the property line, and compare measured levels with required values.

B. Coordinate tests with tests for transfer switches, and run them concurrently.

C. Test instruments shall have been calibrated within the past 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.

D. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.

E. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.

F. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

G. Remove and replace malfunctioning units and retest as specified above.

H. Retest: Correct deficiencies identified by tests and observations, and retest until specified requirements are met.

I. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component, indicating satisfactory completion of tests.

3.7 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's authorized service representative. Include quarterly preventive maintenance and exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Parts shall be manufacturer's authorized replacement parts and supplies.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

END OF SECTION 263213.13

SECTION 263323 **-** CENTRAL BATTERY EQUIPMENT FOR EMERGENCY LIGHTING

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 the following central battery and power conversion equipment rated 600 V and less for emergency lighting:

1. Interruptible (fast-transfer) central battery equipment.

1.3 DEFINITIONS

A. Interruptible: As used in the Section Text, an off-line, passive-standby or line-interactive, inverter-only unit, with an intentional interruption of power to the load until an internal transfer switch picks up and transfers the load to the unit's inverter and internal battery source on loss of the "normal" source, and then retransfers to the "normal" source when it is restored. Transfer time "fast" (2-4 ms or 40-50 ms, depending on manufacturer).

B. OCPD: Overcurrent protective device.

1.4 ACTION SUBMITTALS

A. Product Data: For each type and rating of central battery equipment unit.

1. Include features, performance, electrical ratings, maximum input and output current characteristics, operating characteristics, shipping and operating weights, shipping splits, and furnished options, specialties, and accessories.

B. Shop Drawings: For each type and rating of central battery equipment unit.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, ventilation requirements, method of field assembly, components, and location and size of each field connection.
3. Include system one-line diagram, internal and interconnecting wiring; and diagrams for power, signal, and control wiring.
4. Include elevation, details, and legends of control and indication displays.
5. Include -circuit current (withstand) rating of unit.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around central battery equipment. Show central battery equipment layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

B. Qualification Data: For testing agency.

C. Product Certificates: For each type of central battery equipment.

D. Source quality-control reports.

E. Field quality-control reports.

F. Sample Warranty: For warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For central battery equipment to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

    a. Manufacturer's written instructions for testing central battery equipment.
    b. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
    c. Manufacturer's written instructions for selecting and setting field-adjustable controls and status and alarm points

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Owner.

1. Output Circuit Breakers: One for every 10 of each type and rating, but no fewer than of each type.
2. Output Circuit Breaker Open/Tripped Alarm Contacts: One for every 10 supplied, but no fewer than of each type.
3. Cabinet Ventilation Filters: One complete set.
4. Circuit Board: One spare circuit board for each critical circuit.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Testing Agency Qualifications: Member company of NETA or an NRTL acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

C. Comply with NFPA 70.

D. Comply with NFPA 101.

E. Comply with UL 924.

F. Comply with UL 1778 for UPS systems.

G. Product Selection for Restricted Space: Drawings indicate maximum dimensions for central battery equipment, including clearances between central battery equipment and adjacent surfaces and other items.

1.9 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace central battery equipment that fails in materials or workmanship within specified warranty period. Special warranty, applying to batteries only, applies to materials only, on a prorated basis, for period specified.

1. Warranty Period: Include the following warranty periods, from date of Substantial Completion:

a. Central Battery Equipment (excluding Batteries): One year(s).

b. Lead-Calcium Batteries, 20-Year Life:

1) Full Warranty: One year(s).
2) Pro Rata: 19 years.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR CENTRAL BATTERY EQUIPMENT

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Chloride Systems.
2. Emergi-Lite.
3. LightGuard.
4. Lithonia Lighting.
5. Sure-Lites.
6. Myers Power Products, Inc.

B. Unit Operating Requirements:

See "Ratings" Article in the Evaluations on how to indicate central battery equipment ratings. The Section Text defaults to indicating ratings information (e.g., input/output voltage levels, wattages, etc.) on the Drawings or in tables (see "Sample Schedule" Article in the Evaluations); however, for single units, the Section Text can be revised to incorporate this information.Increases in technology are allowing manufacture of central battery equipment with greater tolerance to system anomalies and better operating performance. Most listed manufacturers offer central battery equipment that tolerates the greater operational variances, or they offer the higher levels of performance included in subparagraphs below. Consult manufacturers if Project system conditions fall outside the selected parameters in first three subparagraphs because corrective actions or additional modifications may be required before central battery equipment can be applied. In "Input AC Voltage Tolerance" Subparagraph below, voltage tolerance is more a factor of voltage limitations for industrial control devices (e.g., magnetic contactors) in central battery equipment and not the central battery equipment power converter, which can usually tolerate greater voltage variations.

1. Input AC Voltage Tolerance: Plus 10 and minus 15 percent of central battery equipment input voltage rating.
2. Input Frequency Tolerance: Plus or minus 3 percent of central battery equipment frequency rating.
3. Synchronizing Slew Rate: 1 Hz per second, maximum.

For most off-line units, the only losses when operating on normal power (i.e., in standby or bypass mode) are the internal bus impedances, the battery charger operating in float-charge mode, and any line-conditioning equipment (e.g., isolation transformers) provided by some listed manufacturers, to reduce incoming power anomalies. Units with integral transformers or similar equipment, to provide input line power conditioning, may have lower efficiencies than those listed below.

4. Minimum Off-Line Efficiency: 99 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or operating condition.

Central battery equipment is available that is suitable for use under environmental conditions different than those indicated in first four rating subparagraphs below; however, derating or special modifications, or both, may be required. For central battery equipment, where converter, battery charger, and batteries are in the same enclosure or same room, the determining factor for ambient operating and storage temperature ranges normally defaults to those specified for the batteries because they are more restrictive. Coordinate with "Field Conditions" Article, and consult manufacturers for required modifications or derating, or both, to accommodate unusual service conditions. See Editing Instruction No. 6 and "Batteries" and "Equipment Rooms" articles in the Evaluations for additional discussions on this subject.

6. Ambient Temperature Rating (Other Than Batteries): Not less than 68 deg F (20 deg C) and not exceeding 86 deg F (30 deg C).
7. Ambient Storage Temperature Rating (Other Than Batteries): Not less than minus 4 deg F (minus 20 deg C) and not exceeding 158 deg F (70 deg C.)
8. Ambient Temperature Rating (Batteries): Not less than 32 deg F (0 deg C) and not exceeding 104 deg F (40 deg C).

Fully charged batteries are normally stored for up to six months at ambient temperatures of not more than 25 deg C; for each 9 deg C rise above 25 deg C, storage time should be reduced by half.

9. Ambient Storage Temperature Rating (Batteries): Not less than 0 deg F (minus 18 deg C) and not exceeding 104 deg F (40 deg C.)
10. Humidity Rating: Less than 95 percent (noncondensing).
11. Altitude Rating: Not exceeding 3300 feet (1005 m).

12. Off-Line Overload Capability: 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.

C. Inverter and Controls Logic: Microprocessor based, isolated from all power circuits; provides complete self-diagnostics, periodic automatic testing and reporting; with alarms.

D. Controls and Indication:

Coordinate local control and indication requirements with Owner or end users. Operator stations and status and alarm displays vary considerably among central battery equipment manufacturers. Most of the indications included in "Status Indication" Subparagraph below can be and are accomplished by listed manufacturers through digital displays in their panel-mounted operator stations; therefore, some listed manufacturers do not offer LED indicators in larger units. Additionally, some listed manufacturers offer only limited LED indicators and do not offer digital displays for smaller, simpler units.

1. Status Indication: Door-mounted, labeled LED indicators or digital screen displaying the following conditions:

   a. Normal power available.
   b. Status of system.
   c. Battery charging status.
   d. On battery power.
   e. System fault.
   f. External fault.

Retain "Panel-Mounted Operator Station" Subparagraph below for all but the smallest units; verify with manufacturers that digital displays are available for unit sizes specified or scheduled on Drawings. Coordinate Project-specific display, alarms, metering, interfaces, and other controls and indication features with manufacturers, because standard and optional features vary considerably among manufacturers.

2. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

   a. Keypad: In addition to required programming and control keys, include the following:

      1) Keys for METER, CONTROL, PROGRAM, and CLEAR modes.
      2) Security Access: Provide electronic security access to controls through identification and password with at least two levels of access: View only; and view, operate, and service.
      3) Control Authority: Supports at least three conditions: Off, local manual control at unit and local automatic control at unit.

   b. Digital Display: Plain-English language messages on a digital display; provide the following historical logging information and displays:

      1) Real-time clock with current time and date.
      2) Tests and Events Logs: Record and store up to 25 tests and events.

         a) Dates.
         b) Times.

c) Durations.
d) Output voltage and currents.

3) Alarm Logs: Record and store up to 25 alarms.

a) Dates.
b) Times.
c) Alarm type.

4) Metering Functions: Display central battery equipment metering parameters including, but not limited to, the following:

a) Input and output voltage (V ac) and output current (A ac).
b) Battery voltage (V dc) and current (A ac).
c) Fault or alarming status (code).
d) Power output (VA).
e) Inverter load (W).
f) Ambient temperature (deg F).
g) System run time (cumulative days).
h) Inverter run time (cumulative minutes).

5) Alarm Functions: Digital display mounted flush in unit door and connected to display central battery equipment parameters including, but not limited to, the following:

a) High/low battery charge voltage.
b) High/low input voltage.
c) Battery nearing low-voltage condition.
d) Battery low voltage.
e) High ambient temperature.
f) Inverter fault.
g) Output fault.
h) Output overload.

3. Remote Signal Interfaces:

a. Remote Indication Interface: A minimum of one programmable (Form C) dry-circuit relay output(s) (120-V ac, 2 A) for remote indication of the following:

1) Fault or status indication.
2) On bypass.
3) Low battery.

Communications interfaces are not typically available on small units below 500 W; some manufacturers only offer these interfaces as added-cost options. Retain "Communications Interface" Subparagraph below if remote programming, monitoring, or both, are required for central battery equipment. Coordinate with manufacturers what is available to suit Project requirements.

b. Communications Interface: Factory-installed hardware and software to enable a remote personal computer to program central battery equipment and monitor and display status and alarms.

Retain "Network Communications Ports" Subparagraph below if the Internet or a local network is used to monitor and program central battery equipment.

1) Network Communications Ports: Ethernet and RS-232 RS-485.

Retain "Compliance with ASHRAE 135" Subparagraph below for BAS control network. Revise as required for other network protocols. See "Optional Features and Accessories" Article in the Evaluations for discussion of communication network options.

2) Compliance with ASHRAE 135: Controllers shall support serial MS/TP and Ethernet IP communications, and shall be able to communicate directly via RS-485 serial networks and Ethernet 10Base-T networks as a native device.

E. Self-Protection and Reliability Features:

Coordinate Project-specific self-protection and reliability features with manufacturers, because standard and optional features vary considerably among manufacturers.

1. Input transient protection by means of surge suppressors to provide protection against damage from supply voltage surges as defined in IEEE C62.45, Category B and C.
2. Integral, programmable, self-diagnostic and self-test circuitry; with alarms and logging.
3. Battery deep-discharge and self-discharge protection; with alarms.
4. Battery self-test circuitry; with alarms and logging.

Not all manufacturers offer options in "Integral Input Disconnecting Means and OCPD" Paragraph below. Coordinate with manufacturers for available options. Coordinate selection of the disconnecting means and OCPD with short-circuit current (withstand) ratings required for Project. See Editing Instruction No. 7 and "Selecting and Setting Protective Devices" Article in the Evaluations for additional information.

F. Integral Input Disconnecting Means and OCPD: Thermal-magnetic circuit breaker, complying with UL 489.

Retain "Integrated Equipment Minimum Short-Circuit Current (Withstand) Rating" Subparagraph below if all central battery equipment on a project requires the same short-circuit current rating. Delete subparagraph if short-circuit ratings vary for individual units, and indicate the ratings on Drawings.

1. Integrated Equipment Minimum Short-Circuit Current (Withstand) Rating: as indicated on drawings.

Inverters are used in all central battery equipment, but they vary considerably in type and function between manufacturers. Coordinate with manufacturers for available features and functions, and revise "Inverter" Paragraph below to suit Project. See "Power Conversion" Article in the Evaluations for additional information on inverters.

G. Batteries:

Retain one of three options in "Description" Subparagraph below. Standard VRLA batteries are the type most frequently offered by manufacturers as a standard, with other types offered only as an added-cost option. Coordinate with "Special Warranty" Paragraph in "Warranty" Article. See "Batteries" Article in the Evaluations for a discussion on types of storage batteries.

1. Description: Lead-calcium, 20-year life batteries, sealed and maintenance free..

NFPA 70 and NFPA 101 require a minimum of 90 minutes of run time; however, some manufacturers offer longer run times as an added-cost option.

a. Capable of sustaining full-capacity output of inverter unit for minimum of 90 minutes.

2. Battery Disconnect and OCPD: Manufacturer's standard.

H. Maintenance Bypass Systems:

See "Maintenance Bypass Systems" Article in the Evaluations for a discussion on this feature. Retain one of two "Maintenance Bypass Mode" subparagraphs below, or retain both if both are required for greater bypass and isolation capabilities for single units or if both are required for separate central battery equipment. Indicate on Drawings where each type is required.

1. Maintenance Bypass Mode: Internal; manual operation only; bypasses central battery equipment power circuits (inverter and static transfer switch); requires local operator selection at central battery equipment. Transfer and retransfer shall be make-before-break, without disrupting power to the load or causing system instabilities.
2. Bypass Overload Capability: 1.5 times the base load current.

I. Integral Output Disconnecting Means and OCPD:

Coordinate Project-specific output OCPDs with manufacturers, because standard and optional features vary considerably among manufacturers. Retain subparagraphs below as required to suit Project. For a single unit, with single-output OCPD, "Single-Output OCPD" Subparagraph below can be revised to include size and type; or, consider scheduling output OCPDs on Drawings for coordination with feeder and branch circuit wiring sizes. Most authorities having jurisdiction require schedules of loads on branch circuits to be indicated on Drawings. See "Selecting and Setting Protective Devices" Article in the Evaluations for additional information.Manufacturers normally offer multiple-output OCPDs as a standard option for other than extremely small unit ratings, with multiple choices of types and features. "Multiple-Output OCPDs" Subparagraph below includes those most commonly encountered; retain as required to suit Project.

1. Multiple-Output OCPDs: Thermal-magnetic circuit breakers, complying with UL 489; voltage rating matching unit output voltage rating; 20 A, single pole.

a. Normally Closed: as indicated on drawings.
b. Normally Open: as indicated on drawings

2.2 INTERRUPTIBLE (FAST-TRANSFER) CENTRAL BATTERY EQUIPMENT

A. Performance Requirements:

1. Fast-Transfer Central Battery Equipment: Passive standby (off-line) system. Automatically sense loss of normal ac supply and use a solid-state static switch to transfer load. Transfer in 2-4 ms or less from normal supply to battery-inverter supply.
2. Automatic Operation:

a. Normal Conditions: Supply the load with ac power flowing from normal ac power input terminals, bypassing inverter, with battery connected in parallel via rectifier/charger output.
b. Abnormal Supply Conditions: If normal ac supply deviates from specified voltage, transfer switch operates and battery supplies constant, regulated ac power through the inverter to the load, with a momentary loss of power to the load.
c. If normal power fails, transfer switch operates and battery supplies constant, regulated ac power through the inverter to the load, with a momentary loss of power to the load.
d. If a fault occurs in system when being supplied by inverter and current flows in excess of the overload rating of inverter, inverter automatically protects itself against damage from overloads and short circuits by shutting down.
e. When normal ac power is restored at input supply terminals of unit, controls automatically retransfer the load back to the normal ac supply, with a momentary loss of power to the load. Rectifier/charger then recharges battery.
f. If normal power failure is prolonged (more than 90 minutes), integral low-voltage battery protective circuit disconnects battery and prevents battery from damage due to deep discharge.
g. If battery becomes discharged, and when normal ac supply is again available, rectifier/charger recharges battery. When battery is fully charged, rectifier/charger automatically shifts to float-charge mode.
h. If battery is disconnected, and normal ac power is available, central battery equipment continues to supply power to the load with no degradation of its regulation of voltage and frequency of output bus.

B. Inverter:

1. Description: Solid-state, high-frequency, pulse-width modulated type, with the following operational features:

a. Automatically regulate output voltage to within plus or minus 3 percent, for all load ranges and for maximum 25 percent step-load changes; regulation may increase to 8 percent for 100 percent step-load changes.
b. Automatically regulate output frequency to within plus or minus 1 Hz, from no load to full load, at unity power factor, over the operating range of battery voltage.
c. Output Voltage Waveform: Sine wave with maximum 3 percent TDD throughout battery operating-voltage range, for 100 percent linear load.
d. Inverter Overload Capability: 115 percent for 10 minutes; 150 percent surge for 10 seconds.
e. Load Power Factor: 0.5 lead to 0.5 lag.
f. Brownout Protection: Produces rated power without draining batteries when input voltage is down to 75 percent of normal.

C. Rectifier/Battery Charger:

1. Description: Solid state, variable rate, temperature compensated; automatically maintains batteries in fully charged condition when normal power is available.
2. Maximum Battery Recharge Time from Fully Discharged State: 24 hours.
3. Low-voltage disconnect circuit reduces battery discharge during extended power outages, monitors battery voltage, and disconnects inverter when battery voltage drops to no less than 85.7 percent of nominal voltage.

2.3 ENCLOSURES

A. Central Battery Equipment Enclosures: NEMA 250, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: Type 1 steel cabinets with access to components through hinged doors with flush tumbler lock and latch.
2. Finish: Manufacturer's standard baked-enamel finish over corrosion-resistant prime treatment.

2.4 OPTIONAL AND ACCESSORY FEATURES

A. Factory-Installed Options and Accessories:

1. Multiple-Output Voltages: Supply unit branch circuits at different voltage levels if required. Transform voltages internally as required to produce indicated output voltages.
2. Split-Output Configuration: Divides output into normally on and normally off buses.
3. Auto-dialer.
4. Internal fax modem.
5. Audible alarm with silencer switch.

6. Remote Meter Panel: Match equipment requirements of remote monitoring, controlling, and programming of central battery equipment.

    a. Cabinet and Faceplate: Surface or flush mounted to suit mounting conditions indicated.
    b. Maximum Distance from Main Unit: 150 feet.

2.5 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate central battery equipment fabricator's quality-control and testing methods.

B. Factory Tests: Test and inspect assembled central battery equipment, by a qualified testing agency, according to UL 924 and UL 1778. Affix standards organization's label. Include the following:

1. Functional test and demonstration of all functions, controls, indicators, sensors, and protective devices.
2. Full-load test.
3. Transient-load response test.
4. Overload test.
5. Power failure test.

C. Central battery equipment will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store central battery equipment according to NECA 411.

B. Examine areas, surfaces, and substrates to receive central battery equipment, with Installer present, for compliance with requirements for installation tolerances, structural support, ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed, before installation begins.

C. Examine equipment before installation. Reject equipment that is wet, moisture damaged, or mold damaged.

D. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Coordinate layout and installation of central battery equipment with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Install central battery equipment and accessories according to NECA 411.

C. Wall-Mounted Central Battery Equipment: Install central battery equipment on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For units not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

D. Suspended-Mounted Central Battery Equipment: Suspend central battery equipment from structural ceiling components using hangers, clamps, and associated fittings, designed for types and sizes of units to be supported. Provide support devices complying with Section 260529 "Hangers and Supports for Electrical Systems."

E. Floor-Mounted Central Battery Equipment: Install central battery equipment on concrete base complying with requirements in Section 260529 "Hangers and Supports for Electrical Systems."

F. Seismic Bracing: Comply with requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

G. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.3 CONNECTIONS

A. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams unless otherwise indicated.

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

1. Separately Derived Systems: Make grounding connections to grounding electrodes and bonding connections to metallic piping systems as indicated.

C. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between central battery equipment and remote devices. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

3.5 IDENTIFICATION

A. Identify central battery equipment, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Operating Instructions: Frame printed operating instructions for central battery equipment, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of central battery equipment units.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

D. Acceptance Testing Preparation:

1. Inspect and Test Each Component:

a. Inspect wiring, components, connections, and equipment installations. Test and adjust components and equipment.
b. Test insulation resistance for all external branch circuit, feeder, control, and alarm wiring connected to central battery equipment element and component.
c. Test continuity of each circuit.

E. Tests and Inspections:

1. Inspect central battery equipment, wiring, components, connections, and equipment installation. Test and adjust components and equipment.
2. Test insulation resistance for all external branch circuit, feeder, control, and alarm wiring connected to central battery equipment element and component.
3. Test continuity of each circuit.
4. Verify that input voltages and frequencies at central battery equipment locations are within voltage and frequency limits specified in Part 2. If outside this range, notify Construction Manager before closing input OCPDs.
5. Perform each visual and mechanical inspection and electrical test stated in manufacturer's written instructions and in NETA Acceptance Testing Specification, including specifically those for batteries, battery chargers, and UPS, regardless of the type of central battery equipment provided. Certify compliance with test parameters.
6. Perform a load-duration test at rated voltage and rated output current to verify the correct functional operation of the unit under full-load stable operating conditions for the minimum time limits required by UL 924. Monitor and record ambient temperature and temperatures within the unit.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of central battery equipment. Remove front panels so joints and connections are accessible to portable scanner.
b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of central battery equipment 11 months after date of Substantial Completion.
c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. Central battery equipment will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies central battery equipment and describes all test results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.8 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, and other adjustable parts.

C. Adjust the trip settings of thermal-magnetic circuit breakers with adjustable, instantaneous-trip elements; install fuses if not factory installed.

D. Set the automatic system test parameters.

E. Set field-adjustable, circuit-breaker trip ranges as specified in Section 260573.16 "Overcurrent Protective Device

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain central battery equipment, and to use and reprogram microprocessor-based control, monitoring, and display functions.

END OF SECTION 263323

SECTION 263600 - TRANSFER SWITCHES

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 automatic and nonautomatic transfer switches rated 600 V and less.

1. Remote annunciator and control system.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for transfer switches.
2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
2. Include material lists for each switch specified.
3. Single-Line Diagram: Show connections between transfer switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.
4. Riser Diagram: Show interconnection wiring between transfer switches, bypass/isolation switches, annunciators, and control panels.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Features and operating sequences, both automatic and manual.

b. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 PRODUCTS

Manufacturers and products listed in SpecAgent and Masterworks Paragraph Builder are neither recommended nor endorsed by the AIA or ARCOM. Before inserting names, verify that manufacturers and products listed there comply with requirements retained or revised in descriptions and are both available and suitable for the intended applications. For definitions of terms and requirements for Contractor's product selection, see Section 016000 "Product Requirements."

2.1 GENERAL REQUIREMENTS FOR TRANSFER SWITCHES

A. 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.

B. Comply with NEMA ICS 1.

C. Comply with NFPA 110.

D. Comply with UL 1008 unless requirements of these Specifications are stricter.

E. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Basis of Design: Kohler Power Systems, Division of Kohler Company

2. Asco.
3. Kohler.
4. Russelectric.

F. Comply with Level 1 equipment according to NFPA 110.

G. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

H. Tested Fault-Current Closing and Short-Circuit Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.

2. Short-time withstand capability for 30 cycles.

I. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.62. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

J. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism. Switches for emergency or standby purposes shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.

Conductor Connections: Front connections.

K. Neutral Terminal: Solid and fully rated unless otherwise indicated.

L. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

M. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, by color-code or by numbered or lettered wire and cable with printed shrinkable sleeve markers at terminations. Color-coding and wire and cable markers are specified in Section 260553 "Identification for Electrical Systems."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
4. Accessible via front access.

N. Enclosures (indoor): General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

O. Enclorsure (outdoor): General-purpose NEMA 250, Type 3R, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.2 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

Type:

C. Molded-Case-Switch Components: Comply with UL 489 and UL 869A.

1. Switch Action: Double throw; mechanically held in both directions.
2. Contacts: Silver composition or silver alloy for load-current switching.
3. Conductor Connectors: Suitable for use with conductor material and sizes. Connectors shall be marked for conductor size and type according to UL 1008.
4. Material: Hard-drawn copper, 98 percent conductivity.
5. Main and Neutral Lugs: Mechanical type.

6. Ground Lugs and Bus-Configured Terminators: Mechanical type.
7. Ground bar.

****** [CHOOSE FROM ONE TYPE FROM B., C., and D. BELOW. NOTE THAT DELAYED- AND CLOSED-TRANSITION SWITCHES MAY NOT BE PERMITTED BY THE LOCAL UTILITY] ******

D. Automatic Open-Transition Transfer Switches: Sources shall be mechanically and electrically interlocked to prevent the load from being closed on both sources at the same time.

1. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.

E. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

F. ElectricSwitch Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternative Source." Switch shall be capable of transferring load in either direction with either or both sources energized.

G. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval shall be adjustable from 1 to 30 seconds.

H. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

I. Automatic Transfer-Switch Controller Features:

1. Controller operates through a period of loss of control power.
2. Undervoltage Sensing for Each Phase of Normal and Alternate Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.

9. Transfer Override Switch: Overrides automatic retransfer control so transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
12. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
13. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is unavailable.

2.3 NONAUTOMATIC TRANSFER SWITCHES

A. Electrically Operated: Electrically actuated by push buttons designated "Normal Source" and "Alternative Source." Switch shall be capable of transferring load in either direction with either or both sources energized.

B. Double-Throw Switching Arrangement: Incapable of pauses or intermediate position stops during switching sequence.

C. Pilot Lights: Indicate source to which load is connected.

D. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and alternative-source sensing circuits.

1. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
2. Emergency Power Supervision: Red light with nameplate engraved "Alternative Source Available."

E. Unassigned Auxiliary Contacts: Switch shall have one set of normally closed contacts for each switch position, rated 10 A at 240-V ac.

F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Switch Action: Double throw; mechanically held in both directions.
2. Contacts: Silver composition or silver alloy for load-current switching.
3. Conductor Connectors: Suitable for use with conductor material and sizes.
4. Material: Hard-drawn copper, 98 percent conductivity.
5. Main and Neutral Lugs: Mechanical type.
6. Ground Lugs and Bus-Configured Terminators: [Compression] [Mechanical] type.
7. Ground bar.

8. Connectors shall be marked for conductor size and type according to UL 1008.

2.4 TRANSFER SWITCH ACCESSORIES

A. Remote Annunciator and Control System:

1. Include the following functions for indicated transfer switches:

   a. Indication of sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
   b. Indication of switch position.
   c. Indication of switch in test mode.
   d. Indication of failure of digital communication link.
   e. Key-switch or user-code access to control functions of panel.
   f. Control of switch-test initiation.
   g. Control of switch operation in either direction.
   h. Control of time-delay bypass for transfer to normal source.

2. Malfunction of annunciator, annunciation and control panel, or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically shall revert to standalone, self-contained operation. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation.
3. Remote Annunciation and Control Panel: Solid-state components. Include the following features:

   a. Controls and indicating lights grouped together for each transfer switch.
   b. Label each indicating light control group. Indicate transfer switch it controls, location of switch, and load it serves.
   c. Digital Communication Capability: Matched to that of transfer switches supervised.
   d. Mounting: Flush, modular, steel cabinet unless otherwise indicated.

B. Power monitoring

1. Include factory installed digital metering

   a. Measure and display voltage, current, frequency and power for both sources.
   b. Programmable visual alarms for high voltage, low voltage and high current
   c. Three digital outputs.
   d. Serial port for optional network connections.
   e. Password protected programming menus.

2.5 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect components, assembled switches, and associated equipment according to UL 1008. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

B. Prepare test and inspection reports.

1. For each of the tests required by UL 1008, performed on representative devices, for emergency, legally required and optional standby systems. Include results of test for the following conditions:

    a. Overvoltage.
    b. Undervoltage.
    c. Loss of supply voltage.
    d. Reduction of supply voltage.
    e. Alternative supply voltage or frequency is at minimum acceptable values.
    f. Temperature rise.
    g. Dielectric voltage-withstand; before and after short-circuit test.
    h. Overload.
    i. Contact opening.
    j. Endurance.
    k. Short circuit.
    l. Short-time current capability.
    m. Receptacle withstand capability.
    n. Insulating base and supports damage.

PART 3 EXECUTION

3.1 INSTALLATION

Wall-Mounting Switch: Install with tops at uniform height and with disconnect operating handles not higher than (2000 mm) above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."Coordinate location of switches, annunciators, control panels, and associated equipment on Drawings.Retain first paragraph below for floor-mounting switches. Coordinate with Drawings.

A. Floor-Mounting Switch: Anchor to floor by bolting.

    1. Install transfer switches on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
    2. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
    3. Provide workspace and clearances required by NFPA 70.

B. Seismic Bracing: Comply with requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Annunciator and Control Panel Mounting: Flush in wall unless otherwise indicated.

E. Identify components according to Section 260553 "Identification for Electrical Systems."

F. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

G. Comply with NECA 1.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to generator sets, control, and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Wiring Method: Install cables in raceways and cable trays except within electrical enclosures. Conceal raceway and cables except in unfinished spaces.

1. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 271500 "Communications Horizontal Cabling."

F. Route and brace conductors according to manufacturer's written instructions and Section 260529 "Hangers and Supports for Electrical Systems." Do not obscure manufacturer's markings and labels.

G. Brace and support equipment according to Section 260548.16 "Seismic Controls for Electrical Systems."

H. Final connections to equipment shall be made with liquidtight, flexible metallic conduit no more than 18 inches in length.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. After installing equipment, test for compliance with requirements according to NETA ATS.
2. Visual and Mechanical Inspection:

a. Compare equipment nameplate data with Drawings and Specifications.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, grounding, and required clearances.
d. Verify that the unit is clean.
e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
f. Verify that manual transfer warnings are attached and visible.
g. Verify tightness of all control connections.

h. Inspect bolted electrical connections for high resistance using one of the following methods, or both:

1) Use of low-resistance ohmmeter.
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.

i. Perform manual transfer operation.
j. Verify positive mechanical interlocking between normal and alternate sources.
k. Perform visual and mechanical inspection of surge arresters.
l. Inspect control power transformers.

1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.
3) Verify correct functioning of drawout disconnecting contacts, grounding contacts, and interlocks.

3. Electrical Tests:

a. Perform insulation-resistance tests on all control wiring with respect to ground.
b. Perform a contact/pole-resistance test. Compare measured values with manufacturer's acceptable values.
c. Verify settings and operation of control devices.
d. Calibrate and set all relays and timers.
e. Verify phase rotation, phasing, and synchronized operation.
f. Perform automatic transfer tests.
g. Verify correct operation and timing of the following functions:

1) Normal source voltage-sensing and frequency-sensing relays.
2) Engine start sequence.
3) Time delay on transfer.
4) Alternative source voltage-sensing and frequency-sensing relays.
5) Automatic transfer operation.
6) Interlocks and limit switch function.
7) Time delay and retransfer on normal power restoration.
8) Engine cool-down and shutdown feature.

4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

a. Check for electrical continuity of circuits and for short circuits.
b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
c. Verify that manual transfer warnings are properly placed.
d. Perform manual transfer operation.

5. After energizing circuits, perform each electrical test for transfer switches stated in NETA ATS and demonstrate interlocking sequence and operational function for each switch at least three times.

a. Simulate power failures of normal source to automatic transfer switches and retransfer from emergency source with normal source available.
b. Simulate loss of phase-to-ground voltage for each phase of normal source.
c. Verify time-delay settings.
d. Verify pickup and dropout voltages by data readout or inspection of control settings.
e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for one pole deviating by more than 50 percent from other poles.
g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

a. Verify grounding connections and locations and ratings of sensors.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Transfer switches will be considered defective if they do not pass tests and inspections.

F. Remove and replace malfunctioning units and retest as specified above.

G. Prepare test and inspection reports.

H. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
3. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.

B. Training shall include testing ground-fault protective devices and instructions to determine when the ground-fault system shall be retested. Include instructions on where ground-fault sensors are located and how to avoid negating the ground-fault protection scheme during testing and circuit modifications.

C. Coordinate this training with that for generator equipment.

END OF SECTION 263600

SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES

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 lightning protection system for ordinary structures.

B. Section includes lightning protection system for the following:

1. Ordinary structures.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include layouts of the lightning protection system, with details of the components to be used in the installation.
2. Include raceway locations needed for the installation of conductors.
3. Details of air terminals, ground rods, ground rings, conductor supports, splices, and terminations, including concealment requirements.
4. Include roof attachment details, coordinated with roof installation.
5. Calculations required by NFC 17102, UNE 21186 Master Label. for bonding of metal bodies.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Lightning protection system Shop Drawings, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Lightning protection cabling attachments to roofing systems and accessories.
2. Lightning protection strike termination device attachment to roofing systems, coordinated with the roofing system manufacturer.
3. Lightning protection system components penetrating roofing and moisture protection systems and system components, coordinated with the roofing system manufacturer.

B. Qualification Data: For Installer.

C. Product Certificates: For each type of roof adhesive for attaching the roof-mounted air terminal assemblies, approved by the roofing-material manufacturer.

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For lightning protection system to include in maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Dimensioned site plan showing dimensioned route of the ground loop conductor and the ground rod locations. Comply with requirements of Section 017839 "Project Record Documents."
b. A system testing and inspection record, listing the results of inspections and ground resistance tests, as recommended by NFC 17102, UNE 21186 Master Label..

B. Completion Certificate:

1. LPI Limited Scope Certification.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: LPI Master Installer.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Advanced Lightning Technology, LTD.
2. East Coast Lightning Equipment Inc.
3. ERICO International Corporation.
4. Harger Lightning & Grounding.
5. Heary Bros. Lightning Protection Co. Inc.
6. Independent Protection Co.
7. National Lightning Protection.
8. Preferred Lightning Protection.
9. Robbins Lightning, Inc.
10. Thompson Lightning Protection, Inc.

2.2 PERFORMANCE REQUIREMENTS

A. NFC 17102, UNE 21186 Master Label.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFC 17102, UNE 21186, "Definitions".

C. Lightning Protection Components, Devices, and Accessories: Listed and labeled by a qualified testing agency as complying with NFC 17102, UNE 21186 Master Label, and marked for intended location and application.

2.3 MATERIALS

A. Air Terminals:

1. Copper unless otherwise indicated.
2. 3/8-inch diameter by 12 inches 15 inches 18 inches 24 inches long.
3. Pointed Rounded tip.
4. Integral base support Threaded base support.

B. Air Terminal Bracing:

1. Copper
2. 1/4-inch diameter rod.

C. Main Conductors:

1. Stranded Copper: 57,400 circular mils in diameter.

D. Main Conductors:

1. Stranded Copper: 115,000 circular mils in diameter.
2. D.Secondary Conductors:

    a. Stranded Copper: 26,240 circular mils in diameter.

E. Ground Loop Conductor: Stranded copper Tinned copper.

F. Ground Rods:

1. Material: Solid copper Copper-clad steel Stainless steel.
2. Diameter: 5/8 inch
3. Rods shall be not less than 120 inches long.

G. Conductor Splices and Connectors: Compression fittings that are installed with hydraulically operated tools, or exothermic welds, approved for use with the class type.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install lightning protection components and systems according to .

B. Install conductors with direct paths from air terminals to ground connections. Avoid bends less than 90 degrees and 8 inches in radius and narrow loops.

C. Conceal conductors within normal view from exterior locations at grade within 200 feet of building. Comply with requirements for:

1. Roof penetrations required for down conductors and connections to structural-steel framework shall be made using listed through-roof fitting and connector assemblies with solid rods and appropriate roof flashings. Use materials approved by the roofing manufacturer for the purpose. Conform to the methods and materials required at roofing penetrations of the lightning protection components to ensure compatibility with the roofing specifications and warranty.
2. Install conduit where necessary to comply with conductor concealment requirements.
3. Air Terminals on Single-Ply Membrane Roofing: Comply with adhesive manufacturer's written instructions.

D. Ground Ring Electrode: The conductor shall be not less than the main-size lightning conductor.

3.2 CONNECTIONS

A. Aboveground concealed connections, and connections in earth or concrete, shall be done by exothermic welds or by high-compression fittings listed for the purpose.

B. Aboveground exposed connections shall be done using the following types of connectors, listed and labeled for the purpose: bolted connectors exothermic weld high compression crimp.

C. 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 bonding so vibration is not transmitted to rigidly mounted equipment.

3.3 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:

1. Perform inspections as required to obtain NFC 17102, UNE 21186 Master Labelfor system.
2. Perform inspections to obtain a NFC 17102, UNE 21186 certification.
3. Prepare test and inspection reports and certificates.

END OF SECTION 264113

SECTION 265000

LUMINAIRES

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. Provide luminaires in accordance with the requirements of the Contract Documents and information referenced to herein.

B. Section Includes:

1. General Requirements
2. Products:
   a. Interior and exterior luminaires and associated components of the project in front of house locations.
   b. Lamps and luminaire accessories
   c. Drivers, ballasts, and transformers for lighting
   d. Light fixture supports

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. Drawings and general provisions of the Contract, including General and Supplementary Conditions, and Division 01 General Requirements Specification Sections, apply to this Section.
2. Section 26 05 00 – Common Work Results for Electrical Requirements
3. Section 26 08 00 – Commissioning of Lighting
4. Section 26 09 23 – Lighting Control Devices
5. Section 26 09 43 – Lighting Controls
6. Section 26 24 16 – Panelboards

D. All luminaires included in 26 50 00 are to be supplied by the contractor.

E. The Contractor is responsible for fixture installation and all necessary accessories including but not limited to wiring to fixtures for power and control, mounting equipment and supports not supplied with fixtures, etc.

1.3 CONTRACT DOCUMENTS

A. All work of this section shall comply with the requirements of the conditions of the contract (general, supplementary and special) with all sections of division 1 – general requirements, with the drawings and with all other contract documents.

B. These documents outline design intent for the architectural electric lighting scope areas. Where design intent is unclear, the Contractor shall contact the Lighting Consultant(s) in writing prior to proceeding with specific item that requires clarification.

C. Where specification refers to Lighting Consultant, this shall mean Ove Arup & Partners P.C., 77

Water Street, New York, NY, all rights reserved.

1.4 DEFINITIONS

A. The language, abbreviations, and acronyms listed below may be used herein to describe the project requirements and salient features of luminaires:

1. CCT: Correlated color temperature.
2. CRI: Color Rendering Index.
3. Fixture: See "Luminaire"
4. IP: International Protection or Ingress Protection Rating.
5. LED: Light-emitting diode.
6. Lumen: Measured output of lamp and luminaire, or both.
7. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.5 REFERENCE STANDARDS

A. General: Comply with the applicable provisions of the referenced standards except as modified by governing codes and the Contract Documents. Where a recommendation or suggestion occurs in the referenced standards, such recommendation or suggestion shall be considered mandatory. In the event of conflict between referenced standards, this specification or within themselves, the more stringent standard or requirement shall govern.

1. ANSI/ASHRAE/IES – Standard 90.1 with New York State and Town of Cornwall Amendments.
2. ANSI C78.377 – Chromaticity
3. CIE TC1-69 - Color Rendering
4. IESNA LM–79 - Approved Method for Electrical & Photometric Measurement of SSL Products
5. IESNA LM–80 - Approved Method for Lumen Maintenance of LED Light Source
6. IESNA RP1605-Nomenclature and Definitions for Illuminating Engineering
7. IESNA TM-30 – IES Method for Evaluating Light Source Color Rendition
8. NEMA LE 4 – Ceiling Compatibility for Recessed Fixtures
9. NFPA 70 - National Electrical Code (NEC)
10. NFPA 101 - Life Safety Code
11. UL 924 - Emergency Lighting and Power Equipment
12. UL 1598 – Luminaires
13. UL 8750 – LED Equipment for Use in Lighting Products
14. ANSI C78.379 Classification of the Beam Patterns of Reflector Lamps
15. ANSI/IEEE C62.41 Guide on Surge Voltages in AC Power Circuits Rated up to 600V

B. All luminaires and components shall be manufactured in accordance with the National Electric Code (NEC) and bear the Underwriter’s Laboratories (UL) or Factory Mutual label.

1. All luminaires installed shall be UL listed for installation in their specific locations and shall comply with article 410 of the National Electric Code.
2. All luminaires shall comply with local, state or federal codes, regulations and building inspection standards. Contractor to verify and provide all required labels indicating compliance with above standards, affixed to each luminaire in a position concealing it from normal view.

1.6 REGULATORY

A. Conform to requirements of ANSI/NFPA 70.

B. Conform to requirements of ANSI/NFPA 101.

C. Furnish products listed and classified by Underwriters Laboratories, Inc., ETL, or testing firm acceptable to authority having jurisdiction (AHJ) as suitable for purpose specified and shown.

D. Conform to the applicable version of ASHRAE/IESNA Standard 90.1.

E. Conform to the requirements of New York State, and related building codes, NEC, and ADA.

1.7 BIDDER EVALUATION & QUALIFICATION MATERIALS

A. The Lighting Consulstant shall retain the right to request additional bidder evaluation and qualification information including but not limited to bidder's company literature describing the firm's qualifications, project or Client references, personnel resumes, company experience and approach to providing the systems and services required for the Project.

B. Submit a list of any anticipated work on the Project that bidder may subcontract. For all subcontracted work, bidder shall describe the work and identify the proposed subcontractor. Appropriate qualification information shall be submitted for each subcontracting firm.

1.8 BID SUBMITTALS

A. General Information:

1. Bids received which omit any portion of these submittal requirements may be deemed non-responsive.
2. The cost for preparing the lighting system bid shall be borne solely by the bidder. No part of the cost of preparing the bid shall be incorporated into the bid itself.
3. Bids shall be submitted in accordance with the instructions outlined in this document.
4. Bidder warrants upon submission of bid that it has reviewed all construction drawings, specifications and related contract documents for the Project and that the bid submitted is inclusive of all labor, materials and supplies required to deliver the complete operational lighting system as specified.
5. All equipment proposed and supplied by the bidder shall be new and shall meet or exceed the technical and performance requirements outlined in this Specification.

B. Technical & Pricing Information:

1. Bidder shall submit itemized list of all equipment proposed to be supplied. Itemized equipment listings must include all equipment necessary to develop the complete functioning systems, whether or not the equipment is specifically identified in this Specification. Each piece of equipment shall be individually priced. Sub-totals shall be provided for each unique system and sub-system.
2. Technical data sheets or other documentation of each major piece of equipment shall be provided upon request to show how each item meets the requirements of the specification.
3. Bidder shall submit schematic diagram(s) illustrating conceptual system architecture where proposed equipment/system deviates from this Specification and accompanying documentation.
4. Itemized bid pricing of luminaires shall exclude installation costs, which is to be itemized separately by function.

C. Other Submittal Information:

1. Bidder shall submit a Warranty Statement clearly identifying any exclusions or conditions affecting warranty of the lighting system. Minimum warranty coverage (Basic Warranty) is defined in the Scope of Work. Bids submitted that do not include Basic Warranty coverage may be deemed non-responsive.
2. Bidder shall submit descriptions and pricing for any supplemental warranty and support

services available, including Enhanced Warranty and Maintenance Support as described in the Scope of Work. Costs for supplemental warranty and support coverage shall be itemized separately and identified in the bidder's submittal as indicated on the Bid Form. Client shall retain the right to accept or reject supplemental warranty and support services as proposed up until commencement of Basic Warranty.

3. Bidder shall identify in the bid submittal any long lead equipment items that may adversely affect the project schedule.
4. Manufacturers listed in the fixture schedule shall be assumed capable of supplying the listed fixtures unless exceptions are set forth in their quotations. Any such exceptions shall immediately be brought to the attention of the Architect and the Lighting Consultant.
5. Manufacturer shall have not less than 5 years of experience in design and manufacture of lighting fixtures of the type and quality shown, unless otherwise specified. Pre-qualification submissions must include a list of completed projects and dated catalog pages or drawings indicating length of experience.
6. Manufacturer shall submit a prototype sample of each fixture for review by the Architect and Lighting Consultant. Prototype samples shall be sufficiently detailed and operational to allow evaluation of compliance with the salient features of the specification. Preliminary design or shop drawing shall not be accepted in place of prototype samples.
7. The Lighting Consultant shall be the sole judge in determining whether the prototype sample complies with the specifications and shall reserve the right to disqualify any bidders.
8. Within 14 days of contract award, successful contractor award, successful contractor shall submit a complete list of lighting products intended to be furnished with manufacturer and catalog designations, along with currently quoted lead times for delivery of same. Should the contractor anticipate that the delivery schedule of any specified product may adversely impact the construction schedule, it shall be brought to the attention of the Architect at this time.

D. Within 14 days of bid award, contractor shall provide a complete list of all lamps, which will be furnished on the project. This list shall be organized alphabetically by the luminaire type indicated on the luminaire schedule, and include the manufacturer and exact model number of each lamp. Up to three samples of any listed lamp shall be supplied at no additional cost to the project, if so requested by the specifier.

1.9 SUBMITTALS

A. The Contractor shall submit shop drawings, samples and prototypes as specifically instructed below. Shop drawings shall include but not be limited to:

1. Manufacturer's dimensioned scale drawings showing in complete detail the fabrication of all luminaires including overall fixtures, continuous fixture run lengths, and detail dimensions, finishes, metal thickness, glass thickness, type, fabrication methods, support method, ballasts, transformers, sockets, type of shielding, reflectors, trims, hinges, gaskets, provisions for re-lamping and all other information to show compliance with the contract documents.
2. Installation instructions.
3. Certified independent laboratory test data and reports including photometric data rendered by an independent testing laboratory developed according to methods of the Illuminating Engineering Society of North America.
4. Maintenance and operating instructions, including tools required, types of cleaners to be used, replacement parts identification list, and final as-built shop drawings.

B. All drawings shall clearly indicate the contract drawing number of luminaire details used as reference in the development of the shop drawings and the name of the project, Architect and Lighting Consultant.

C. Submittals shall not be submitted piecemeal through the project. We expect to receive submittals as follows:

1. 1 submittal package inclusive of all luminaires (OUR PREFERENCE)
   OR
2. No more than 2 submittal packages indicating one for buildings and one for site

D. Light Fixture Submittal Review

1. An orderly process for reviewing the light fixture Submittal(s) and shop drawings is required. Contractor shall submit (1) package of light fixtures Front of House Scope separate from Back-of-House project scope. We expect this package to be received as one entire collection of light fixtures in a single package. We will not accept each light fixture as a separate Submittal.
2. We expect the Contractor to provide the first name fixtures in the package, as specified in the first Submittal. Any proposed substitutions shall follow the procedures outlined in these specifications, inclusive of comparative uninstalled unit pricing, with corresponding labor rates for installation.
3. Contractor to provide itemized list of base unit costs of fixtures as well as the cost including installation, indicated separately.
4. After this process, an in-person review of operational Physical samples of exact luminaires shall be undertaken of all fixtures in one package. This review will include all stakeholders.
5. After the physical sample review, a final set of documentation, taking on board any and all comments and direction from the previous dialog, for submission is issued and reviewed.
6. Any fixture that is part of the fixture sample review may not be returned nor used in the final project installation.

E. Submittal log showing all luminaire designations shall be submitted with each submittal showing the current review status of each fixture type.

F. Allow a minimum of (15) business days for review by the Lighting Consultant. Process may require more time for additional party review.

1.10 SAMPLES

A. Samples may be requested for any or all of the luminaires specified herein and are required for all luminaires designated as ‘modified’ or ‘custom luminaires’ as well as all contractor substitutions.

B. Submit for review samples called for to the Lighting Consultant when and where directed, the components tagged with the name of the project and provided with a cord and plug and specified lamps. Samples will not be returned. Allow 2 weeks from the date of receipt for thorough examination and review by the Lighting Consultant.

C. Luminaires under the contract shall be identical with the approved sample Luminaire. No luminaire used as a sample will be allowed to be installed on the project.

D. In the event the submissions are disapproved, the luminaires will be returned to the Contractor to immediately make a new submission of luminaire or luminaires meeting the contract requirements.

E. All charges for these shipments are to be prepaid by the Contractor.

F. Prototypes: All custom luminaires require a submission of material finish samples, component review and a complete operating prototype luminaire to be reviewed at the fabricator’s shop prior to shipment of any material to the project.

G. The Contractor shall submit shop drawings for all luminaires no later than 60 days after award of contract. The Contractor shall be responsible for coordinating submittal reviews to allow timely delivery to the project site.

H. Shop drawings and samples requested shall be submitted for review before fabrication. Any material produced prior to the review of shop drawings or samples and not in conformance with

the contract documents shall be disapproved with the Contractor bearing full responsibility and cost.

I. When required and requested by the Lighting Consultant, samples submitted as per above shall be subjected to photometric, thermal, mechanical, electrical or water testing at an independent test laboratory, at no additional expense to Owner.

J. Luminaire sample submittals shall include an operable 120-volt non-returnable sample, complete with lamp(s), 72 inch grounded cord and plug, and specified finish.

K. 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 review.

1.11 WORK INCLUDED

A. The contractor shall install a luminaire of the type indicated by designation at each location shown on the drawings. All materials, accessories, and any other equipment necessary for the complete and proper installation of all luminaires included in the contract shall be furnished by the contractor.

B. Luminaires shall be manufactured in strict conformance with the contract drawings and specifications. Specifications and scale drawings are intended to convey the salient features, function, and character of the luminaire only, and do not undertake to illustrate or set forth every item or detail necessary for the work. Minor details not usually indicated on the drawings nor specified, but that are necessary for the proper completion of luminaire installation, shall be included as if they were herein specified or indicated on the drawings.

C. The Owner, Architect, and Lighting Consultant shall not be held responsible for omission or absence of any detail, construction feature, etc., that may be required in the production of the luminaires.

D. The responsibility of accurately fabricating and installing the luminaires to the fulfillment of this specification rests with the contractor.

1.12 QUALITY ASSURANCE

A. 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. Luminaire 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 luminaires.

B. All luminaires shall be manufactured to a consistent level of quality. Size, color and components parts shall be identical for all Luminaires.

C. All new luminaires and related materials shall be new.

D. The Contractor shall coordinate all luminaires, mounting hardware, and trim with ceiling system and other items, including work of other trades.

1.13 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 260500 “Basic Electrical Requirements”.

B. Accurately record actual locations of each luminaire, which proper luminaire designation and control circuiting, for preparation of As-Built drawings and corresponding luminaire schedules to

be submitted upon completion of the project.

1.14 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Division 1.

B. Operations and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

C. Provide a list of all lamp types used on Project; use ANSI and manufacturer codes.

D. Include list of all replacement part.

1.15 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: 10 for every 100 of each type and rating installed, unless otherwise indicated. Furnish at least one of each type.
2. Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
3. Drivers: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
4. Luminaires (Standard White Goods): 1 for every 100 of each type. Furnish at least one of each type.
5. Battery and Charger: 1 for every 20 of each emergency lighting unit

1.16 OPERATING PARAMETERS

A. All interior components shall be designed to operate properly between 50°F and 115°F without increased failure rate; in addition to any stated conditions below such as cold weather starting ballasts or drivers.

All exterior fixtures shall be suitable for outdoor environmental conditions and be exterior rated.

1.17 SUBSTITUTIONS

A. Alternate products other than those listed by name in the specification will not be considered without prior written consent from the Lighting Consultant.

B. Substitutions for the specified lighting products are not acceptable and will not be considered in the bid process. Failure to include one of the specified products as a part of the base bid may, at the discretion of the Architect, invalidate the entire lighting product bid and exclude the contractor from further consideration.

C. Should the contractor wish to have considered products other than those specified, the items must be submitted 7 days in advance of the bid. Failure to submit within that deadline constitutes a guarantee that the specified products will be supplied. The Lighting Consultant will invoice the contractor, at appropriate hourly rates, to review any product not listed in the specification. Submittal of a bid for this project shall include a written acknowledgement of these terms for the contractor.

D. Equal manufacturers identification by means of manufacturers' names and catalogue numbers is required to establish basic features and performance standards. Any substitutions must meet or exceed these standards. Qualifications: Within sixty days of placement of order, Contractor must furnish independent photometric tests and samples for all alternative luminaires. If these luminaires fail to comply with the specification requirements at that time, Contractor will furnish

acceptable luminaires at no additional cost to Owner and with no delay to the project.

E. Any submittals for cost reduction alternates or value engineering shall include unit prices for the specified manufacturer, the specified equal manufacturer and the proposed alternate.

F. The Lighting Consultant shall be the sole judge in determining whether proposed substitutions comply with the specifications and shall reserve the right to reject any proposed substitutions.

G. Any subtitutions need to be sumitted during the bid/ project buyout phase.

H. Substitions need to be submitted via Luminaire Broker. Please refer to Project Number 271565-00 on luminairebroker.com.

1.18 WARRANTY

A. The Contractor shall warrant the fixture, its finishes and all or 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.

B. Warranty for LED Luminaires: Manufacturer's standard form in which manufacturer agrees to repair or replace luminaires that fail in materials or workmanship within specified warranty period.

1. Warranty Period for LED Luminaires: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MATERIALS

A. Provide materials as specified with the following characteristics:

1. Stainless steel:
   a. AISI type 302 or UNS type S30200 18-8 grade: 18% chromium and 8% nickel austenitic 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

B. Galvanized steel: coated steel with zinc by a method of hot dipping on electroplating.

C. Aluminum: a pure metal, aluminum and aluminum alloys meeting the national standard ANSI H35.1-1982

D. Bronze: copper alloy, principal alloying elements are phosphor, aluminum, silicon and tin

E. 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).

F. Copper: a pure metal. Copper or high copper alloy containing less than 6% alloying elements. Wrought copper has UNS designation C10000. Cast copper has UNS designation C80100 to C82800.

G. Zinc: a pure metal. May be specified as an alloying element in copper and aluminum.

H. 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% or laminated safety glass. For exterior luminaires, use Borosilicate glass, tempered, Corning #7740. For luminaires directly exposed to the elements and aimed above horizontal with radiant energy of 4.16 watts per square inch or greater, use Vycor glass.

I. Acrylic: 100% virgin acrylic polymer, colorless

J. Neoprene: all neoprene rubber should be heat resistant to withstand heat generated by lamp operation.

K. Silicone: plastic based on silicon which is not an organic compound. Suitable for use in a wide temperature range (-80 to +500º F). Used as an additive to plastic to improve adhesion, increase strength and improve water resistance.

2.2 FABRICATION

A. Provide thickness of metal required or as specified so that all luminaires are rigid, stable and will resist deflection twisting, warping or bending under normal installation procedures, loading, relamping, etc. or no less than as follows:

1. All steel luminaire housings minimum 20 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 acrylic lenses minimum 0.1875” thick
5. All glass lenses minimum of 0.375” thick
6. All cast aluminum or bronze housings minimum of 0.375” thick
7. All sheet bronze, steel, aluminum or other metal plate minimum of 22 gauge

B. Provide neoprene or silicone gasketing, stops, and barriers where required to prevent light leak or water and water vapor (penetration).

2.3 FINISHES

A. Luminaire finishes shall be applied in a manner that will assure a durable, wear resistant surface.

B. Prior to finishing, all surfaces shall be free from foreign materials such as dirt, rust, oil, polishing compounds and mould release agents.

C. Where necessary, surfaces shall be hot cleaned by accepted chemical means and shall receive corrosion inhibiting (phosphating) treatment assuring positive paint adhesion.

D. Exposed metal surfaces used in interior areas, except chromium-plated parts, shall be given an even coat of high grade metacrylate lacquer, or transparent epoxy with a satin finish.

E. All castings, extrusions and spinnings shall be machined, sanded or similarly treated and given minimum one coat of baked-on clear metacrylate lacquer, unless a painted finish is specified, to provide a consistent texture, color and finish throughout all exposed surfaces.

F. Exterior metal surfaces such as extruded parts or castings that 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.

G. Aluminum surfaces exposed to the weather shall receive a duronodic or polyester powder paint or clear metacrylate 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.

H. Sheet steel luminaire housings, iron and steel parts, which have not received phosphate treatment ('Bonderizing' or similar process) or are to be used 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:

1. Hot galvanized zinc coating: 0.00050
2. Cadmium plating: 0.00015

I. Parts operated under temperatures injurious to hot-dipped galvanizing shall be electroplated.

J. 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.

K. Completely form painted reflectors before application of primer and enamel color coats. Reflectors and reflector bodies for fluorescent lamp luminaires 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 the following requirements and tests:

1. Initial reflection factor not less than 86%
2. After 100 hours of exposure to a fade-o-meter, reflection factor not less than 85% and finish shows no visible color change
3. Exposure for 48 hours to either hydrogen sulphide or sulphur dioxide causes no more than slight yellowing and no blistering
4. A spot test with 5% potassium hydroxide at room temperature for four hours shows no effect other than a loss of not over 15% gloss
5. Contact with 5% soda ash solution at room temperature for 24 hours shows no effect
6. Exposure to 100% humidity at 110º F for 100 hours (Cook Box Test) shows no blistering or other effects
7. Salt spray (20% sodium chloride) for 150 hours causes no breakdown of film
8. Tabor Abrasion Test shows no more than 15mgm per 500 cycles, using CS-10 wheel
9. Erickson Bump Test shows a minimum of 0.12" of penetration before cracking
10. Sward Hardness Test minimum of 30
11. Specular gloss, in accordance with ASTM method D-523-T, procedure A, minimum of 80

L. When requested by the Lighting Consultant, 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 a recognized 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.

2.4 WIRING

A. All wiring shall comply with the following:

1. All wiring devices within Luminaires or from the Luminaire to the splice with project branch circuit wiring shall be as specified below.
2. Wiring between lampholders and associated operating and starting equipment shall be of similar or heavier gauge than the leads furnished with the approved types of drivers, transformers or ballasts with equal or better insulating and heat resisting characteristics.
3. Wire leads to the receptacle or connector of any side-prong incandescent lamp or any 'cool-beam' lamp using a dichroic reflector shall be SF-2 (silicone rubber insulated) stranded wire.

Wire within housing entirely covered with flexible woven fiberglass sleeve.

4. Wiring shall be protected with tape or tubing at all points where abrasion may occur.
5. Wiring shall be concealed within the luminaire construction except where design or mounting dictates otherwise.
6. 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.
7. Joints in wiring within luminaires and connections of the luminaire wiring to the wiring of the building shall be as specified Section 260519 'Low Voltage Conductors and Cables".
8. 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.
9. Insulated bushings shall be installed at points of entrance and exit of flexible wiring.
10. Junction boxes attached to luminaires shall be manufactured in accordance with the National Electrical Code and listed for the number of conductors indicated on the drawings. Supplementary junction boxes shall be installed where required to comply with Code.
11. All exposed wire shall be jacketed with a flexible woven fiberglass sleeve or similar flexible metallic or armored cable (BS) or EMT type conduit.
12. When exposed, all junction boxes and conduit to be painted as per the architects' direction.

2.5 MARKING OF LUMINAIRES

A. Markings shall be clear and located to be readily visible to service personnel, but invisible from normal viewing angles when lamps are in place.

B. Luminaires designed for voltages other than 110-125 volts shall be marked with operating voltage.

C. Luminaires equipped for operation of a specific lamp type shall be clearly marked 'USE _____ LAMPS ONLY'.

D. Luminaires 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.

2.6 SOUND TRANSMISSION

A. Sound transmission through the light luminaire 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 luminaires where sound transmission levels are unacceptable.

B. Luminaires shall not produce audible noise when installed.

2.7 THERMAL PROTECTORS

A. Provide thermal protectors as required by the NEC, or as required by local code, to prevent operation of luminaires in enclosed spaces or adjacent to combustible materials at rated temperatures at or above 90°C (194°F).

B. Luminaires listed for operation in fire-resistant material at temperatures up to 150°C (302°F) shall be plainly marked.

2.8 LAMPS

A. Lamps as specified for the individual luminaires or lighting equipment shall be delivered and installed in luminaires and lighting equipment leaving these completely lamped and in normal

operating condition.

B. Luminaires shall not be installed to track until aiming and adjustment takes place, just prior to the project's completion.

C. Architectural lighting shall not be operated for work light at any time during construction, nor shall it be illuminated for any other reason. Failure to comply with this requirement will make necessary the replacement of fixtures by the contractor at no additional cost to Owner just prior to turnover of area to Owner.

D. Unless indicated otherwise on luminaire data sheets, all lamps shall have a CRI greater than 90, and shall be 3500K color temperature.

2.9 LED (LIGHT EMITTING DIODE) MODULES

A. Color Quality

1. Correlated Color Temperature (CCT)
   a. CCT shall be 3500K unless otherwise indicated.
2. Color Consistency
   a. CCT Tolerance: CCT tolerance shall be +/- 50K.
   b. Chromaticity: All LED sources at the same CCT shall fall within a maximum of 2 MacAdam ellipses on the CIE 1931 xy chromaticity diagram
   c. Duv Tolerance: Color shift from the black body curve between different LED modules at the same color temperature shall be less than or equal to +/- .002.
   d. Color Consitency Over Time: After 50,000 hours of illumination, individual fixtures or LED modules shall not have more color shift than is listed above for CCT tolerance, Chromaticity, and Duv tolerance.
3. Color Rendering Index (CRI)
   a. Aggregate Value: The aggregate CRI value of the source shall be greater than 90. Aggregate value shall be calculated based on IESNA TM-30-15.
   b. R9 Value: The CRI value at CRI reference color R9 shall be greater than 90.

B. Spectral Data

1. Spectral Power Distribution shall be available and provided for each source at maximum 10 nm increments from 380 nm to 780 nm.

C. Ultraviolet Light Output (UV)

1. Light output power at 400nm and below shall be 0.

D. Lamp Life

1. Rated Lumen Maintenance Life (per LM-80-08) shall be minimum 50,000 hours at L_{70}.

E. Maintenance

1. Both LED module and driver shall be able to be replaced without soldering or sending the luminaire back to the manufacturer. Quick-connect devices are preferred.

F. Warranty

1. Warranty on complete luminaire assembly (driver, LED module, fixture housing) shall be a minimum of 5 years. Warranty shall be by luminaire manufacturer as the sole source of service.

G. Testing, Reports and Listings

1. The following reports and listings shall be completed by the manufacturer through an independent testing lamp and available during the design process for review, and required for construction submittals:
   a. LM-79-08 – Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products.
   b. LM-80-08 – Approved Method: Measuring Lumen Maintenance of LED Light Sources
   c. TM-30-15 – Method of Evaluating Light Source Color Rendition
   d. Light source spectral power distribution data at 10 nm increments from 380 to 780 nm.
   e. UL listed as a complete luminaire.

2.10 LED DRIVERS

A. General Requirements:

1. Operate for at least 50,000 hours at maximum case temperature and 90 percent non-condensing relative humidity.
2. Provide thermal fold-back protection by automatically reducing power output (dimming) to protect LED driver and LED light engine/fixture from damage due to over-temperature conditions that approach or exceed the LED driver's maximum operating temperature at calibration point.
3. Provide integral recording of operating hours and maximum operating temperature to aid in troubleshooting and warranty claims.
4. Designed and tested to withstand electrostatic discharges without impairment when tested according to IEC 61000-4-2.
5. Manufactured in a facility that employs ESD reduction practices in compliance with ANSI/ESD S20.20.
6. UL 8750 recognized or listed as applicable.
7. UL Type TL rated where possible to allow for easier fixture evaluation and listing of different driver series.
8. UL 1598C listed for field replacement as applicable.
9. Designed and tested to withstand Category A surges of 4,000 V according to IEEE C62.41.2 without impairment of performance.
10. Class A sound rating; Inaudible in a 27 dBA ambient.
11. Demonstrate no visible change in light output with a variation of plus or minus 10 percent change in line-voltage input.
12. LED drivers of the same family/series to track evenly across multiple fixtures at all light levels.
13. Offer programmable output currents in 10 mA increments within designed driver operating ranges for custom fixture length and lumen output configurations, while meeting a low-end dimming range of 100 to 1 percent or 100 to 5 percent as applicable.
14. Meet NEMA 410 inrush requirements for mitigating inrush currents with solid state lighting sources.
15. Employ integral fault protection up to 277 V to prevent LED driver damage or failure in the event of incorrect application of line-voltage to communication link inputs.
16. LED driver may be remote located up to 100 feet (30 m) from LED light engine depending on power outputs required and wire gauge utilized by installer.

B. Compatibility with lighting control protocol

1. Contractor shall verify and confirm all LED drivers are compatible with the lighting control protocol from the overall lighting control system, devices, control modules and associated control points.

C. 3-Wire Control:

1. Provide integral fault protection to prevent driver failure in the event of a mis-wire.
2. Operate from input voltage of 120 V through 277 V at 50/60 Hz.

D. Digital Control:

1. Employ power failure memory; LED driver to automatically return to the previous state/light level upon restoration of utility power.
2. Operate from input voltage of 120 V through 277 V at 50/60 Hz.
3. Automatically go to 100 percent light output upon loss of control link voltage and lock out system commands until digital control link voltage is restored.
4. Each driver responds independently per system maximum.
5. Responds to digital load shed command. (Example: If light output is at 30 percent and a load shed command of 10 percent is received, the ballast automatically sets the maximum light output at 90 percent and lowers current light output by three percent to 27 percent).
6. Digital low-voltage control wiring capable of being wired as either Class 1 or Class 2.

E. Product(s):

1. Forward Phase (Neutral Wire Required), One Percent Dimming:
   a. Dimming Range: 100 to one percent relative light output.
   b. Complies with FCC requirements of CFR, Title 47, Part 15, for commercial and residential applications at 120 V.
   c. Total Harmonic Distortion (THD): Less than 20 percent at full output; complies with ANSI C82.11.
   d. Constant Current Drivers:
   e. Support for light fixtures from 200 mA to 2.1 A to ensure a compatible driver exists.
   f. Pulse Width Modulation (PWM) or Constant Current Reduction (CCR) dimming methods available.
   g. UL listed.
   h. Constant Voltage Drivers:
   i. Support for light fixtures from 10 V to 60 V (in 0.5 V steps) to ensure a compatible driver exists.
   j. Pulse Width Modulation (PWM) dimming method.
   k. UL listed.

F. 3-Wire and Digital Control, One Percent Dimming:

1. Dimming Range: 100 to one percent relative light output.
2. Complies with FCC requirements of CFR, Title 47, Part 15, for commercial applications at 120 V or 277 V.
3. Total Harmonic Distortion (THD): Less than 20 percent at full output; complies with ANSI C82.11.
4. Constant Current Drivers:
   a. Support light fixtures from 200 mA to 2.1 A to ensure a compatible driver exists.
   b. Pulse Width Modulation (PWM) or Constant Current Reduction (CCR) dimming methods available.
   c. UL listed.
5. Constant Voltage Drivers:
   a. Support for light fixtures from 10 V to 60 V (in 0.5 V steps) to ensure a compatible driver exists.
   b. Pulse Width Modulation (PWM) dimming method.
   c. UL listed.

2.11 REFLECTORS

A. 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 equal
4. Specular finish color as selected by the architect or as specified in paragraph 3.04 of this section
5. All reflector and baffles of modified elliptical contour, with no apparent brightness from above 40° above the nadir, with no lamp image or any part of the lamp visible from above 40° above the nadir
6. Cone flange formed as an integral part of the cone and with identical color and finish. Width of the flange covers all ceiling opening without light leaks or hardware visible.

B. 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 equal unless otherwise noted.

C. Samples of colored aluminum finishes (black, brass, bronze etc.) shall be submitted for review before fabrication.

D. All reflectors shall be finished according to the minimum requirements outlined below.

1. Class MI for normal interior service
   a. Minimum Weight of Coating: 0.5 mg/sg in.
   b. Minimum Reflectivity: 83% Specular; 75% Diffuse
2. Class SI for medium service, interior industrial, exterior when operated within glass
   a. Minimum Weight of Coating: 7.5 mg/sg in.
   b. Minimum Reflectivity: 82% Specular; 73% Diffuse
3. Class SE for exterior industrial or commercial service, exposed to atmosphere, and marine service enclosure
   a. Minimum Weight of Coating: 10 mg/sg in.
   b. Minimum Reflectivity: 78% Specular; 65% Diffuse
4. Class M for marine service not protected by enclosure
   a. Minimum Weight of Coating: 13 mg/sg in.
   b. Minimum Reflectivity: 78% Specular; 65% Diffuse

2.12 LENSES

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 that require removal for relamping or normal maintenance shall be attached to the luminaire 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.

C. Glass lenses specified as translucent or 'opal' shall be treated as follows:

1. Sand blasted
2. Acid etched
3. White flashed

D. Acrylic lenses shall be 100% virgin acrylic polymer, colorless, as manufactured by Rohm Hass, or

Dupont.

E. The quality of the raw acrylic material must exceed IES, SPI and NEMA specifications by at least 100% which, as a minimum standard, shall not exceed yellowness factor of 3 after 2000 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.

2.13 LOUVERS

A. All louvers shall be fabricated of the specified material.

B. Louver finishes shall be provided as specified.

C. All plastic parabolic louvers shall be destaticized before and after fabrication to insure minimum maintenance.

D. All metal louvers shall be coated with anti-rust material and electrostatically painted.

E. All louvers shall be heat tested to withstand lamp-operating temperatures with no deformation of shape, paint blistering or discoloration.

2.14 LUMINAIRE TRIMS

A. Luminaires shall have finish trim designed for the ceiling types into which they are being installed.

1. Recessed luminaires:
   a. Plaster TL – trimless
   b. Concrete IR – inside reveal
   c. Wood OL – overlap trim
   d. Gypsum TL – trimless

B. Contractor shall confirm trim type for recessed luminaires is compatible with ceiling types.

2.15 EMERGENCY LIGHTING

A. Emergency lighting installation shall adhere to applicable code for project location.

B. Designated emergency luminaires shall be provided with emergency power from a generator, separate service, central battery, or distributed battery packs.

C. When battery packs are used to supply power for emergency lighting, an appropriate test apparatus shall be installed in accordance with the applicable code, in locations per Architect's direction.

D. Emergency power for emergency lighting shall be capable of operating for a duration of 90 minutes without falling below 60% of initial light output.

E. Infrastructure for temporary emergency lighting units shall be provided, along with a selection of units.

2.16 EXIT SIGNS

A. Exit signs shall be by the Architect and meet the following requirements:

1. Use only light emitting diodes (LED) as light sources.

2. Local Code Compliant
3. Must be warranted for at least 20 years.
4. Be UL listed.
5. Have left and right arrows available on all signs.
6. Single-sided 8 inch signs shall use no more than 5 watts.
7. Double-sided 8 inch signs shall use no more than 8 watts.
8. THD shall not exceed 10%.
9. Minimum power factor of 0.9.
10. Shall have continuous stroke lettering.

B. Exit signs shall have the following attributes unless otherwise indicated in the luminaire data sheets:

1. Manufacturers:
   a. Cooper Lighting

C. Housing: Die Cast aluminum. Mounting type to recessed unless otherwise indicated on drawings to be determined based on ceiling conditions – exit sign shall have options for wall, ceiling, and pendant mounting.

D. Face: Polished extruded acrylic edge lit panel shall have precision etched letters 8” high. Color of letters shall be red with LED sensitive inks. Background color shall be clear.

E. Direction Arrows: As indicated on drawings.

F. Mounting: Recessed; unless indicated otherwise on drawings.

G. Lamps: LED - Manufacturer's standard.

H. Input Voltage: 120 volts.

2.17 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage (2.68 mm).

F. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

2.18 DISCONNECTS

A. All fixtures shall be provided with disconnecting means to allow the ballast or driver to be serviced in place. Acceptable means include a switch integral to the luminaire or quick connect latching modular plug between ballast and branch circuit, internal to the luminaire.

2.19 REQUIREMENTS FOR INDIVIDUAL LIGHTING FIXTURES

A. Refer to Luminaire Data Sheets in Part 4 of this section with manufacturer information and requirements. Features noted within the product data sheets shall be considered part of the fixture requirements for any named manufacturers.

PART 3 EXECUTION

3.1 INSTALLATION

A. The Contractor shall coordinate exact quantities and critical dimensions with field conditions.

B. The Contractor shall 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 ensure a timely, neat installation of all luminaires.

C. The Contractor shall coordinate and provide any associated mounting hardware, conduit connections, or associated appurtenances to effectively install the luminaires. Provide each light luminaire with complete installation instructions. All luminaires to be installed in strict conformance with manufacturer's recommendations and instructions.

D. Exact locations and orientations of all luminaires including mounting heights and plan dimensions shall be per the architectural drawings. Any ambiguities or conflicts in this dimensional information shall be identified to the Architect prior to installation.

E. Do not install exposed luminaires, reflectors or trims until all plastering and painting that may mar luminaire finish is completed. Replace blemished, dented, damaged or unsatisfactory luminaires and mounting surfaces as directed.

F. Set units plumb, square, and level with ceiling and walls, and secure according to manufacturer's written instructions and approved Shop Drawings. Set all trims for uniform alignment

G. Support luminaires according to requirements.

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.
5. Support all luminaires independent of ductwork or piping.

H. Pole Mounted Luminaire:

1. Fasten luminaire to indicated structural supports.
2. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
   Adjust aimable lighting fixtures under supervision of Lighting Consultant (Arup) as designated by Architect. Contractor shall coordinate meeting time for aiming at night with Lighting Consultant and a work crew as determined necessary by lighting Consultant. All required equipment shall be available for aiming, including ladders or other lift equipment, and lamps and accessories as specified.

I. Structural Analysis Criteria For Pole Selection

1. All load criteria for poles shall be verified with the Structural Engineer by the Contractor.

2. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.
3. Ice Load: Load of 3 lbf/sq. ft. (145 Pa), applied as stated in AASHTO LTS-4-M Ice Load Map.
4. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.

J. DELIVERY, STORAGE, AND HANDLING

1. Package aluminum poles for shipping according to ASTM B 660.
2. Store poles on decay-resistant-treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
3. Handle wood poles so they will not be damaged. Do not use pointed tools that can indent pole surface more than 1/4 inch (6 mm) deep. Do not apply tools to section of pole to be installed below ground line.
4. Retain factory-applied pole wrappings on fiberglass and laminated wood poles until right before pole installation. Handle poles with web fabric straps.
5. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

K. Pole Installation:

1. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
2. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:
   a. Fire Hydrants and Storm Drainage Piping: 60 inches (1520 mm).
   b. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet (3 m).
   c. Trees: 15 feet (5 m) from tree trunk.

L. Field Conditions

1. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.
2. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

M. Flush-Mounted Luminaire Support:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

N. Wall-Mounted Luminaire Support

1. Attached to structural members in the wall or backing plate attached to wall structural members. Backing plates may exist on either side of the wall or both and mush be fully concealed from view unless otherwise indicated.
2. Do not attach luminaires directly to gypsum board.

O. Ceiling-Mounted Luminaire Support:

1. Ceiling mount with two 5/32-inch diameter aircraft cable supports adjustable to 120 inches.
2. Ceiling mount with pendant mount two 5/32-inch diameter aircraft cable supports adjustable to 120 inches.

3. Ceiling mount with hook mount.

P. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod support for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

Q. Ceiling-Grid-Mounted Luminaire Support:

1. Units may be supported from suspended ceiling support system. Install ceiling support system rods or wires at a minimum of 4 rods or wires for each luminaire, located not more than 6 inches (150 mm) from luminaire corners.
2. Install support clips for recessed luminaires, securely fastened to ceiling grid members, at or near each luminaire corner.
3. Luminaires Smaller than Ceiling Grid: Install a minimum of 4 rods or wires for each luminaire and locate at corner of ceiling grid where luminaire is located. Do not support luminaires by ceiling acoustical panels.
4. Luminaires of sizes less than ceiling grid: Center in acoustical panel unless indicated otherwise. Support luminaires independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.

R. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

S. Lamping: Where specific lamp designations are not indicated, lamp units according to manufacturer's instructions.

T. Luminaire attachment for exterior luminaires: Fasten to structural supports by means of wall brackets.

U. Install surface mounted luminaires and exit signs plumb and adjust to align with building lines and with each other. Secure to prohibit movement.

V. The Contractor shall 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 ensure a timely, neat installation of all luminaires.

W. The Contractor to coordinate and provide any associated mounting hardware, conduit connections, or associated appurtenances to effectively install the luminaires.

X. The Contractor shall rigidly align all continuous rows of luminaires for true in-line appearance.

Y. Install recessed luminaires using accessories and fire stopping materials to meet regulatory requirements for fire rating.

Z. Install wall mounted luminaires and exit signs at height as indicated on Drawings.

AA. Install accessories furnished with each luminaire.

BB. Install specified lamps in each luminaire.

CC. Install recessed fixtures with trim tight to ceiling, not allowing light leaks onto the ceiling.

3.2 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replaced damaged luminaires and components.

B. Give advance notice of dates and times for field tests.

C. Provide instruments to make and record test results.

D. Tests: Verify normal operation of each luminaire after luminaires have been installed and circuits have been energized with normal power source. Interrupt electrical energy to demonstrate proper operation of emergency lighting installation. Include the following information in tests of emergency lighting equipment:

1. Duration of supply.
2. Low battery voltage shutdown.
3. Normal transfer to battery source and retransfer to normal.
4. Low supply voltage transfer.
5. Photometric Tests: Measure light intensities at night at locations where specific illumination performance is indicated. Use photometers with calibration referenced to National Institute of Standards and Technology (NIST) standards.
6. Check for intensity of illumination.
7. Check for uniformity of illumination.
8. Check for excessively noisy ballasts or drivers.
9. Prepare written report of tests indicating actual illumination results.

E. Replace or repair malfunctioning luminaires and components, then retest. Repeat procedure until all units operate properly.

F. Report results of tests.

G. Replace luminaires that show evidence of corrosion during Project warranty period.

H. Correct all comments from any punch list or site report.

3.4 FOCUS AND ADJUSTMENT

A. All adjustable lighting units shall be aimed, focused, locked etc by the Contractor by direction or under the supervision of the Lighting Consultant.

B. A pre-focus meeting shall be held with the Contractor and Lighting Consultant to review initial aiming strategy for all adjustable and orientation specific luminaires. The Lighting Consultant shall indicate the scope of the adjustments required during this coordination exercise with the various contractors, who then shall determine the number of crews (foreman and apprentice) required.

C. All focusing and adjusting shall be carried out after the entire installation is complete and working including the lighting control system. All ladders, scaffolds, lifts, etc. required shall be furnished by the Contractor at the direction of the Lighting Consultant or as needed for access. As aiming and adjusting is completed, locking setscrews and bolts and nuts shall be tightened securely.

D. Where possible, units shall be focused during the normal working day based on the pre-focus

meeting and further refinement of focusing shall occur after dark where daylight interferes with seeing the effect of the luminaire. This refinement shall be accomplished after dark or during the night, at a time mutually agreeable to Contractor, Lighting Consultant, Architect and Owner. Adjustments shall be made by the Contractor in accordance with the Lighting Consultant's stated intent, under his/her observation. This may require multiple focusing sessions.

E. A focus and adjustment session under the base scope shall be held upon completion of the entire project for focus and aiming of all light fixtures across the project which may include but is not limited to the following:

1. Interior architectural lighting
2. Exterior lighting

3.5 CLEANUP

A. At the time of final acceptance by the Architect, all luminaires shall have been thoroughly cleaned with materials and methods recommended by the manufacturers, any visible damage or broken parts shall have been replaced and all lamps shall be operative.

3.6 DEMONSTRATION

A. Provide systems demonstration under provisions of Division 1.

B. Provide for a minimum two-hour demonstration of luminaire operation and maintenance.

PART 4 LUMINAIRE DATA SHEETS AND LIGHTING CONTROLS NARRATIVE

4.1 ATTACHMENTS

A. Fixture Schedule with Luminaire Data Sheets and associated information are appended after this section.

B. Lighting Controls Narrative.

(REFER TO "265000 LUMINAIRES PART 4A.PDF" AND "265000 LUMINAIRES PART 4B.PDF" ATTACHED)

END OF SECTION

Remove page

Remove page

Type:

Landscape Lighting

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page

Remove page

Manufacturer: Structura: Mac II
Description: Wood body LED bollard

Fixture Wattage: 12 W
Lumen Output: Standard
Lamp CRI: 80+
Lighting Controls: 0-10V Dimming

Voltage: 120 V
Fixture Finish: Finish to be specified by landscape architect
Lamp CCT: 2700K
Assembly Code: MAC-32-L27-SO-3-XX-XX-UNV-STD

Mac Wood Body LED Bollard

structura

FIXTURE TYPE: _____

PROJECT NAME: _____

Glulam solid wood bollard with LED light source.

FEATURES:

- High power, low wattage LED light module
- Solid glulam wood construction
- Concealed anchor bolt base and mounting hardware

SPECIFICATIONS:

HOUSING: Solid wood bollard is assembled through glulam construction and precision machined using CNC technology. Adhesive complies with ASTM D-2559 glulam construction specifications for extreme exposed weather conditions and is waterproof and rated for wet or dry use exposure.

Glulam wood is fastened to a concrete anchor bolt base with concealed hardware accessible from top access plate. Anchor bolt kit includes (4) hot dip galvanized anchor bolts and fasteners and a ridged concrete pour template.

ELECTRICAL: Powered by a Class P 120-277VAC primary integral power supply. Standard output is 12W. Fixture is internally prewired to the electrical splice box located in the fixture base. System is 0-10V dimmable. Minimum -40°C operating temperature.

OPTICAL SYSTEM: LED boards have solderless connections for field upgradability. Available in 2700K, 3000K, 3500k and 4000K color temperatures with >90 CRI. Optics are UV resistant molded PMMA in Type III and IV distributions. Consult factory for additional lumen output, CCT, and optical distribution options.

FINISHES AND MATERIALS: Woods are finished with a low VOC waterborne matte exterior finish containing UV and mildew inhibitors. All aluminum parts are polyester powder coat painted. Care and Maintenance

HARDWARE: Fasteners are stainless steel. Anchor bolt kits are hot dip galvanized.

LISTINGS & RATINGS: Luminaire CSA listed according to CSA C22.2 No. 250.0-18/UL Standard 1598. Suitable for wet locations. LM-80 test reported L70 > 60,500 hours and calculated L70 > 154,000 hours.

60 ©2021 STRUCTURA, INC.

Type:

AB01

Page 1 of 3

Lighting Notes:

1. Contractor to coordinate conduit routing to driver with electrical and civil scope.
2. Add Alternate - remote driver hidden in bollard.
3. Type III distribution with asymmetrical lens to be provided.
4. Coordinate mounting with civil scope.

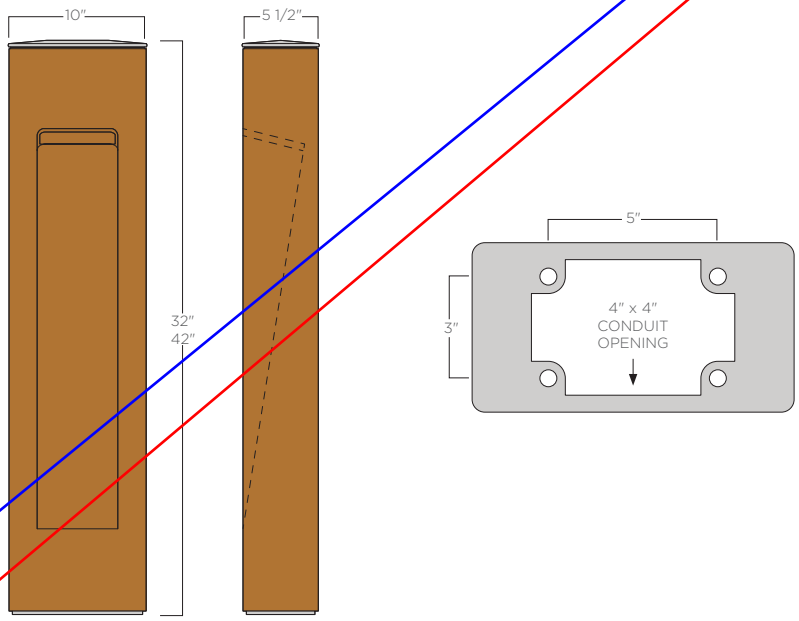
ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page Remove page

Type:

AB01

structura



ORDERING GUIDE: EXAMPLE: MAC-32-L30SO-4-S6-C5-120-STD

MAC		SO				UNV	
1	2	3	4	5	6	7	8	9

1	Series
MAC	Mac

2	Overall Height
32	32″
42	42″

3	Color Temperature
L27	2700K LED
L30	3000K LED
L35	3500K LED
L40	4000K LED
AMB	Amber

4	Light Source[1]
SO	Standard Output

5	Distribution
3	Type III
4	Type IV

6	Wood Finish
S*	See color options on finishes technical sheet

7	Metal Finish
C*	See color options on finishes technical sheet Custom Color
CSM	

8	Voltage
UNV	120-277V

9	Special
STD	Standard
MOD	Modified

1. Consult factory for additional output options

Product specification sheets subject to change.

©2021 STRUCTURA, INC.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page

Remove page

Type:

AB01

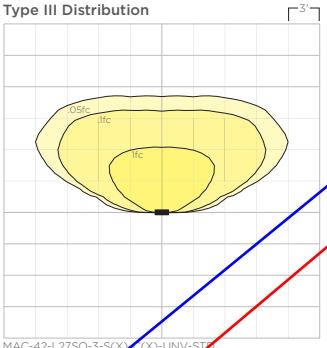
Mac Wood Body LED Bollard

structura

FIXTURE TYPE: _____

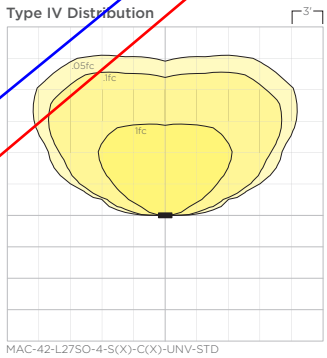
PROJECT NAME: _____

Type III Distribution



MAC-42-L27SO-3-S(X)-C(X)-UNV-STD

Type IV Distribution



MAC-42-L27SO-4-S(X)-C(X)-UNV-STD

IES file download

62 ©2021 STRUCTURA, INC.

ARUP

Project Number: 271565
Phone: 1 212 896 3000

Remove page Remove page

Manufacturer: Ecosense : Trove
Description: Wallwasher

Fixture Wattage: 6 W
Lumen Output: 482 lumen
Lamp CRI: 80+
Lighting Controls: 0-10V Dimming

Voltage: 120 V
Fixture Finish: Finish to be specified by landscape architect
Lamp CCT: 2700K
Assembly Code: L50-E-48-06-27-80-MULT-9x29

TROV®

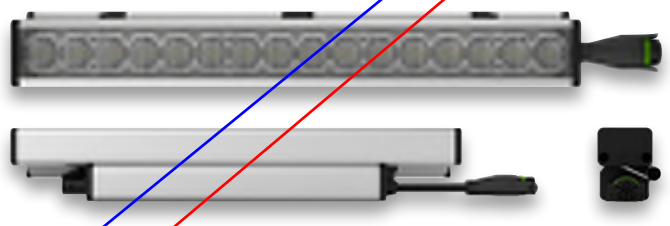
OVERVIEW • SPECIFICATIONS • ORDERING | INTERIOR + EXTERIOR | **L50 WASH**

DATE | PROJECT | FIRM | TYPE

THE L50 INCLUDES PATENTED OPTICAL DESIGN THAT DELIVERS THE WIDEST RANGE OF BEAM ANGLE OPTIONS FOR PRECISE COVE, WALL GRAZING, WALL WASHING OR LINE OF LIGHT APPLICATIONS. EXCLUSIVE FLIP TO FLAT™ HINGE DESIGN PROVIDES FLEXIBILITY WHEN MANAGING SMALL COVE DETAILS. TROV OFFERS SMOOTH, FLICKER FREE DIMMING DOWN TO 0%.

FEATURES :

- DIM TO 0%, ELV REVERSE PHASE
- 24 BEAM ANGLES
- MULTI-VOLT
- FLIP TO FLAT™
- 6 CCT OPTIONS
- 80+ AND 90+ CRI OPTIONS
- IP54 INTERIOR AND IP66 EXTERIOR OPTIONS



MODEL/ SIZE	INTERIOR/ EXTERIOR	LENGTH	POWER	CCT		CRI	VOLTAGE	OPTICS	
L50	I E	12″ 48″	02 04 06 08 10 12	**WHITE CCT** 22 27 30 35 40 50	**MONO COLOR** GR**** BL AM RD***	80 90* Blank For Color	MULT (120-277V)	**GRAZING** 9 x 9 9 x 17 9 x 29 9 x 59 15 x 15 15 x 23 15 x 35 15 x 65 **COVE** 120** Asym **LINE OF LIGHT** LOL	**WASHING** 25 x 25 25 x 33 25 x 45 25 x 75 39 x 9 55 x 25 40 x40 40 x 48 40 x 60 40 x 90 45 x 15 70 x 40 70 x 70

EXAMPLE: L50-I-48-10-27-90-MULT-15x65 *90 CRi not available in 2200K or 5000K **120 is only available with Exterior option. See L35 spec sheet for interior cove options. ***Red is not available in 12W or 10W. ****Green is not available in 12W.

PERFORMANCE	WATTS	OPTIC	LUMEN OUTPUT	EFFICACY
	2W	40˚x 60˚	110 lm/LF (361 lm/m)	55 lm/W
	4W	40˚x 60˚	302 lm/LF (1037 lm/m)	76 lm/W
	6W	40˚x 60˚	482 lm/LF (1614 lm/m)	80 lm/W
	8W	40˚x 60˚	675 lm/LF (2224 lm/m)	84 lm/W
	10W	40˚x 60˚	785 lm/LF (2644 lm/m)	79 lm/W
	12W	40˚x 60˚	923 lm/LF (3201 lm/m)	77 lm/W

ALL LUMEN DATA IS FROM 4000K 80CRI FIXTURES. PLEASE SEE PHOTOMETRY SPEC SHEET FOR ADDITIONAL LUMEN DATA.

COLOR RENDERING INDEX 80+, 90+
COLOR CONSISTENCY 2-STEP MACADAM ELLIPSE
LUMEN DEPRECIATION / RATED LIFE

WATTS	L70 @ 25C	L70 @ 50C	L90 @ 25C	L90 @ 50C
2W-12W	>150,000	>70,000	>50,000	>25,000

*CALCULATIONS FOR LED FIXTURES ARE BASED ON MEASUREMENTS THAT COMPLY WITH IES LM-80 TESTING PROCEDURES AND IES TM-21 CALCULATOR

* CALCULATIONS FOR LED FIXTURES ARE BASED ON MEASUREMENTS THAT COMPLY WITH IES LM-80 TESTING PROCEDURES AND IES TM-21 CALCULATOR

ELECTRICAL

POWER CONSUMPTION 2W*/LF (6.6W/M) ; 4W/LF (13.2W/M) ; 6W/LF (19.8W/M) ; 8W/LF (26.4W/M) ; 10W/LF (33W/M) ; 12W/FL (39.6W/M)
* 3W/LF (9.9W/M) at 220V -277V

MAX FIXTURE RUN LENGTH

	2W/LF		4W/LF		6W/LF		8W/LF		10W/LF		12W/LF	
Volts	Max Run all 1'	Max Run all 4'	Max Run all 1'	Max Run all 4'	Max Run all 1'	Max Run all 4'	Max Run all 1'	Max Run all 4'	Max Run all 1'	Max Run all 4'	Max Run all 1'	Max Run all 4'
120	214	214	186	186	152	152	114	114	91	91	76	76
220	374	392	340	340	277	277	209	209	95	167	95	139
277	374	494	374	428	349	349	263	263	95	190	95	175

POWER FACTOR 4W, 6W, 8W, 10W, 12W >0.9, 2W<0.9
OPERATING VOLTAGE MULTIVOLT: 110-277VAC, 50/60 Hz
DRIVER INTEGRAL TO FIXTURE; DE-RATED POWER AND SYNCHRONOUS START-UP AT FULL BRIGHTNESS
STARTUP TEMPERATURE -40˚F TO 122˚F (-40˚C TO 50˚C)
OPERATING TEMPERATURE -40˚F TO 122˚F (-40˚C TO 50˚C)
STORAGE TEMPERATURE -40˚F TO 176˚F (-40˚C TO 80˚C)

NOTE: Information on this Spec Sheet is subject to change, please visit ecosenselighting.com/downloads/rise for the most updated information.

ECOSENSE®

ECOSENSE LIGHTING INC.
837 NORTH SPRING STREET
SUITE 103
LOS ANGELES, CA 90012

P • 310.496.6255
F • 310.496.6256
T • 855.632.6736
855.6.ECOSEN

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE. VISIT **ECOSENSELIGHTING**.COM FOR THE MOST CURRENT SPECIFICATIONS.
© 2019 **ECOSENSE** LIGHTING INC. ALL RIGHTS RESERVED. **ECOSENSE**, THE **ECOSENSE** LOGO, **RISE**, **TROV**, **SLIM COVE** AND **ECOSPEC** ARE REGISTERED TRADEMARKS OF **ECOSENSE** LIGHTING INC.
FREEDOM TO CREATE™

1/3

Type:
ADS01

Page 1 of 4

Lighting Notes:

1. Coordinate length with Landscape Drawings and confirm with Wayfinding Consultant.
2. Contractor to coordinate conduit routing to fixture with electrical and civil scope.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page Remove page

TROV®

OVERVIEW • SPECIFICATIONS • ORDERING

INTERIOR + EXTERIOR | **L50 WASH**

Type:
ADS01

DATE	PROJECT	FIRM	TYPE

CONTROL	**DIMMING**	110-277VAC, ELV TYPE 0.07%-100%, REVERSE PHASE, TRAILING EDGE ETC control systems require 0-10V control using EcoSense LDCM. TROV will not work with ETC phase dimmers.
PHYSICAL	**DIMENSIONS**	W 1.6" x H 2" x L 12"/48" ; (41.6mm x 50.5mm x 304.7mm/1201mm)
	HOUSING /LENS	EXTRUDED ALUMINUM; UV STABILIZED POLYCARBONATE; STAINLESS STEEL FASTENERS; PLASTIC ENDCAPS RUBBER OVERMOLD FOR CABLE ASSEMBLY
	WEIGHT	1.52LBS / 0.69KG (1FT) ; 4.95LBS / 2.25KG (4FT)
	CONNECTORS	INTEGRAL MALE/ FEMALE CONNECTORS
	ENVIRONMENT	INDOOR • ETL CERTIFIED FOR DRY/DAMP LOCATIONS IP54 OUTDOOR • ETL CERTIFIED FOR WET LOCATIONS IP66 IMPACT RATED TO IK10 Not intended to be used in water features such as waterfalls, fountains, etc.
	BEAM ANGLE	GRAZING, WASHING, COVE, ASYMMETRIC, LINE OF LIGHT
	MOUNTING OPTIONS	INTEGRAL MOUNTING AND ADJUSTABLE AIMING FROM 0°-180° IN 15° INCREMENTS
FIXTURE RATING & CERTIFICATIONS	**CE, ETL CERTIFIED** **RoHS COMPLIANT** **ENERGY STAR COMPLIANT** **RCM CERTIFIED**	Title 24 JA8-2016 *90 CRI models only
LIMITED WARRANTY	**5 YEARS**	

WIRING OPTIONS (MVOLT): 110-277VAC

Power Cable Assembly, TROV, Leader/Jumper, 10 foot CBL-3P-L-UNV-10*
Power Cable Assembly, TROV, Leader/Jumper, 50 foot CBL-3P-L-UNV-50*
Power Cable Assembly, TROV, Jumper, 5 foot CBL-3P-L-UNV-05**
Power Cable Assembly, TROV, Jumper, 1 foot CBL-3P-L-UNV-01**
Power Cable Assembly, TROV, Male and Female terminator caps CBL-3P-L-UNV-CAPS

*Two (2) terminators are included with the 10' and 50' power cable. One Leader need per circuit/fixture run. Cables are not plenum rated.
** If using the 5' or 1' power cable assembly as a leader to power a run one set of CBL-3P-L-UNV-CAPS will also be need per cable.

0-10V CONTROL OPTIONS

100-120VAC / 277VAC Linear Dimming Control Module 0-10V - Plenum Rated LDCM-PL-120-277-010V-GR
All products come standard with ELV dimming capabilities. 0-10V Control options required for operation at 0-10V.

OPTIONAL ACCESSORIES

Mounting

Mounting Track and Clips Set, 48 Inch Track, 8 Clips	MNT-L-TRKCLIP-48	48" track and clips set will work with one 48" fixture or four 12" fixtures. (FOR INTERIOR USE ONLY)
Mounting Track and Clips Set, 12 Inch Track, 2 Clips	MNT-L-TRKCLIP-12	12" track will not work with 48" fixtures. (FOR INTERIOR USE ONLY)
Mounting Track Clip, TROV, Set of 2	MNT-L-CLIP	Clips needed = 12" fixtures need 1 set of 2 and 48" fixture needs 2 sets of 2.
90 Degree L bracket, TROV, Set of 2	MNT-L-LBKT	L-Brackets needed = 12" fixtures need 1 set of 2 and 48" fixture needs 1 set of 2.
Angle Locking Clip, TROV, Pack of 10	MNT-L-ANGLOCK	Angle Locks needed = 12" fixtures need 1 and 48" fixtures need 2. (Must order separately)
Mounting, Fine Adjustment Bracket, TROV	MNT-L-FAB	Fine Adjustment Brackets needed = 12" fixtures need 1 and 48" fixtures need 2.
*Fine Adjustment Bracket is highly recommended for Grazing Optics.		
Mounting, Fine Adjustment L-Bracket, TROV	MNT-L-LFAB	Fine Adjustment L-Brackets needed = 12" fixtures need 1 and 48" fixtures need 2.
*Fine Adjustment L-Bracket is recommended for Asymetric Optics when aiming is needed.		

Snap-on Lenses

Snap-on Lens, Frosted, 12 inch, L50	LENS-L50-FROST-12	Snap-on Lenses need = One 12" lens is needed per 12" fixture and one 48" lens is needed per 48" fixture. Snap on Lenses will not work with the asymmetric fixture. Clear lenses can be used to hold colored filters to customize the output color of any TROV fixture, except the ASYM. Color filters supplied by others.
Snap-on Lens, Frosted, 48 inch, L50	LENS-L50-FROST-48	
Snap-on Lens, Clear, 12 inch, L50	LENS-L50-CLEAR-12	
Snap-on Lens, Clear, 48 inch, L50	LENS-L50-CLEAR-48	

Wall Mount Arm

Wall Mount Arm, 6 inch, TROV	WMA-L-CA-06	Wall Mount Arms needed = For individual fixture installations two arms and one end set will be needed per fixture. For continuous run installation one endset will be needed per run. Each end set contains one left and one right end plate. One joining set wll be needed per joint. One arm per fixture will be need plus one extra arm to complete the run. For example: A 10ft run made with two 4ft and two 1ft fixtures will contain; 1 x WMA-L-END, 3 x WMA-L-JNR, and 5 x WMA-L-CA-12. Leader cables are not included with wall mount arms, end sets, or joiners sets.
Wall Mount Arm, 12 inch, TROV	WMA-L-CA-12	
Wall Mount Arm, 18 inch, TROV	WMA-L-CA-18	
Wall Mount Arm, 24 inch, TROV	WMA-L-CA-24	
Wall Mount Arm End Plate Set, TROV, Includes Left and Right	WMA-L-END	
Wall Mount Arm Joiner Plate, TROV	WMA-L-JNR	

Louvers

Louver, Asymmetric, 12 inch, L50	LV-L50-ASYM-12	Louvers Needed = One 12" louver is needed per 12" fixture and one 48" louver is needed per 48" fixture. 48" louver is made up of four 12" louvers. Louvers cannot be used with the asymmetric fixture
Louver, Asymmetric, 48 inch, L50	LV-L50-ASYM-48	
Louver, Symmetric, 12 inch, L50	LV-L50-SYM-12	
Louver, Symmetric, 48 inch, L50	LV-L50-SYM-48	
Louver, Honeycomb, 12 inch, L50	LV-L50-HCOMB-12	
Louver, Honeycomb, 48 inch, L50	LV-L50-HCOMB-48	

ECOSENSE®

ECOSENSE LIGHTING INC.
837 NORTH SPRING STREET
SUITE 103
LOS ANGELES, CA 90012

P • 310.496.6255
F • 310.496.6256
T • 855.632.6736
855.6.ECOSEN

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE. VISIT **ECOSENSELIGHTING**.COM FOR THE MOST CURRENT SPECIFICATIONS.
© 2019 **ECOSENSE** LIGHTING INC. ALL RIGHTS RESERVED. **ECOSENSE**, THE **ECOSENSE** LOGO, **RISE**, **TROV**, **SLIM COVE** AND **ECOSPEC** ARE REGISTERED TRADEMARKS OF **ECOSENSE** LIGHTING INC.
FREEDOM TO CREATE™

20210119

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page Remove page

TROV

OVERVIEW • SPECIFICATIONS • ORDERING

INTERIOR + EXTERIOR | **L50 WASH**

Type:
ADS01

DATE	PROJECT	FIRM	TYPE

OPTIONAL ACCESSORIES

Masking Plates

Masking Plate, 3 inch high, 12 inch, L50 & L35 ..... **MP-L50-3H-12**
Masking Plate, 3 inch high, 48 inch, L50 & L35 ..... **MP-L50-3H-48**

Masking Plates needed = One 12" plates is needed per 12" fixture and one 48" plates is needed per 48" fixture.

Landscape Stake

Landscape Stake, 6 inch, TROV, Set of 2 ..... **LS-L-STK-06**
Landscape Stake, 12 inch, TROV, Set of 2 ..... **LS-L-STK-12**
Landscape Stake, 18 inch, TROV, Set of 2 ..... **LS-L-STK-18**

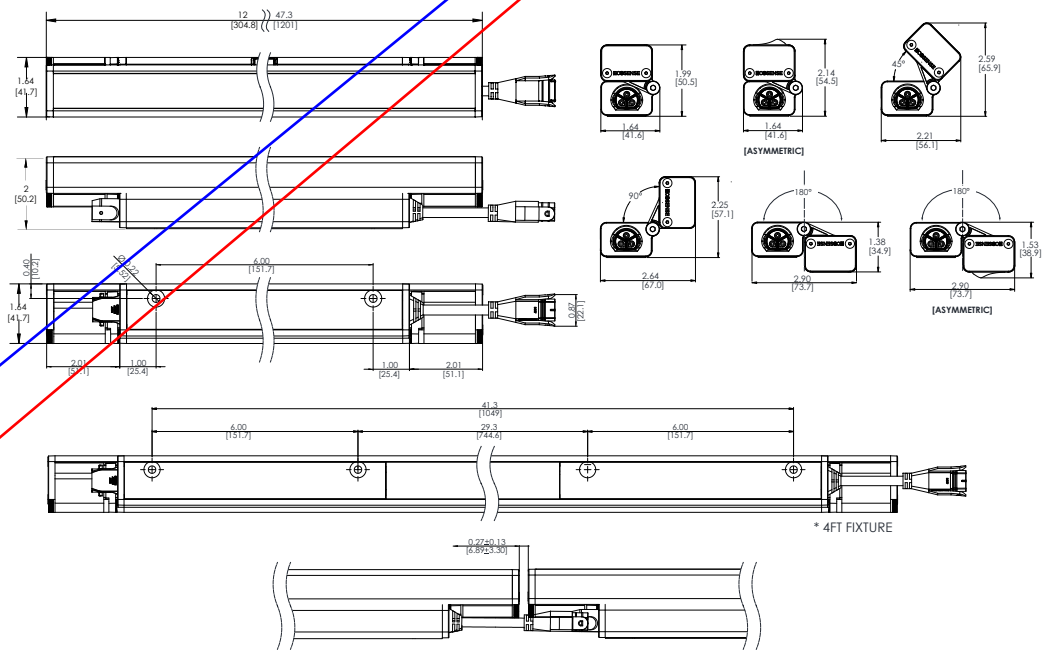
Landscape Stakes needed = 12" and 48" fixtures both need one set of 2.

Wire Box

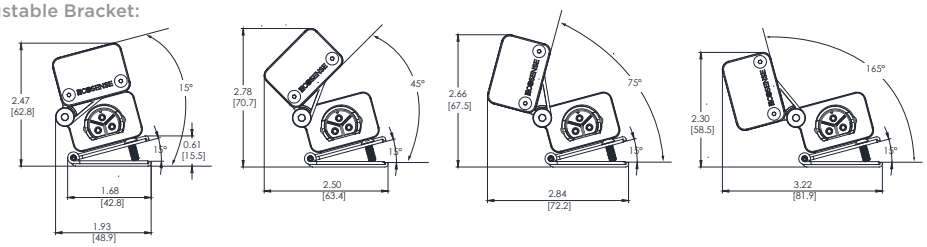
Conduit Connection, Wire Box, TROV, Interior Only, L50 .....**CC-L-WIREBOX**

Wire box can be used instead of a leader cable to start a run. 1/2" conduit fitting can attach directly to the box on one end and the fixture to the other.

DIMENSIONS + MOUNTING



Fine Adjustable Bracket:



ECOSENSE

ECOSENSE LIGHTING INC.
837 NORTH SPRING STREET
SUITE 103
LOS ANGELES, CA 90012

P • 310.496.6255
F • 310.496.6256
T • 855.632.6736
855.6.ECOSEN

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE. VISIT **ECOSENSELIGHTING**.COM FOR THE MOST CURRENT SPECIFICATIONS.
© 2019 **ECOSENSE** LIGHTING INC. ALL RIGHTS RESERVED. **ECOSENSE**, THE **ECOSENSE** LOGO, **RISE**, **TROV**, **SLIM COVE** AND **ECOSPEC** ARE REGISTERED TRADEMARKS OF **ECOSENSE** LIGHTING INC.
FREEDOM TO CREATE™

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page

Remove page

ECOSENSE®

TRŌV

OVERVIEW • SPECIFICATIONS

ACCESSORIES | **LANDSCAPE STAKE**

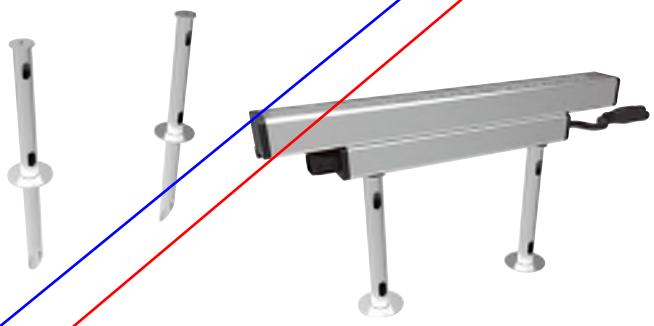
Type:
ADS01

DATE	PROJECT	FIRM	TYPE

TROV LANDSCAPE STAKES ARE IDEA FOR MOUNTING THE FIXTURE IN THE GRASS OR DIRT. THEY ARE TYPICALLY USED TO LIGHT SIGNAGE IN LANDSCAPES

FEATURES :

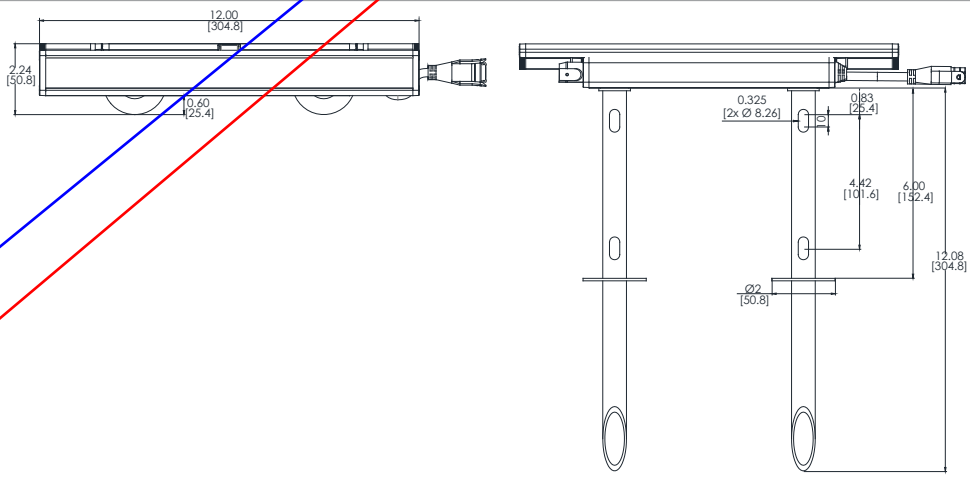
- COMPATIBLE WITH L35 AND L50 SERIES FIXTURES
- MOUNT DIRECTLY INTO THE GROUND
- AVAILABLE IN 6", 12" AND 18" ABOVE GROUND HEIGHTS



PHYSICAL

DIMENSIONS W 2" x H 6/12/18" x L 2" ; (50.8mm x 152.4/304.8/457.2mm x 50.8mm) APPROX

MATERIAL CLEAR ANODIZED ALUMINUM



ORDERING

TYPE	MODEL/SIZE	FINISH	LENGTH
LS - LANDSCAPE STAKE	L	STK	06 - 6" 12 - 12" 18 - 18"

EXAMPLE LS-L-STK-06

ONE SET OF LANDSCAPE STAKES INCLUDE TWO PIECES

LIMITED WARRANTY **5 YEARS**

ECOSENSE LIGHTING INC.
915 WILSHIRE BLVD
SUITE 2175
LOS ANGELES, CA 90017

P • 310.496.6255
F • 310.496.6256
T • 855.632.6736
855.6.ECOSEN

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE. VISIT **ECOSENSELIGHTING**.COM FOR THE MOST CURRENT SPECIFICATIONS.

© 2015 **ECOSENSE** LIGHTING INC. ALL RIGHTS RESERVED. **ECOSENSE**, THE **ECOSENSE** LOGO AND **ECOSPEC** ARE REGISTERED TRADEMARKS OF **ECOSENSE** LIGHTING INC.

ECOSENSELIGHTING.COM

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page

Remove page

Manufacturer: Selux : Lenova LED Pole Mount
Description: 14ft Pole Light R3 Type Distribution

Fixture Wattage: 24 W
Lumen Output: 2477 lumen
Lamp CRI: 80+
Lighting Controls: 0-10V Dimming

Voltage: 120 V
Fixture Finish: Dark Gray
Lamp CCT: 2700K
Assembly Code: LAL-R3-X-CL-5G250-XX-30-SP-120-DM-MOD

Date: _____ Customer: _____

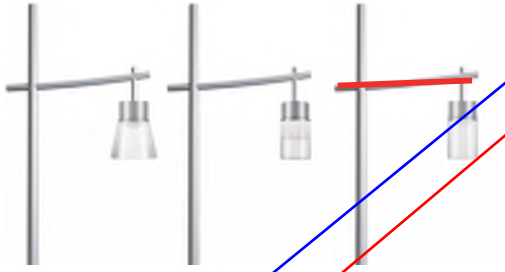
Project: _____

Type: _____ Qty: _____

selux

Type:
ALP01

Lanova LED Pole Mount



straight arm

Order Code: LAL - ____ - ____ - ____ - ____ - ____ - ____ - ____ - ____ - ____ - ____

Pole Order Code: ____ - ____ - ____ - ____

		Series	Height	Finish	Options
LAL	Series	LAL Lanova LED			
	Optics	R1 Type I Distribution; R2 Type II Distribution; R3 Type III Distribution; R4 Type IV Distribution; R5S Type V Square; R5R Type V Round; DB Diffuse Bowl			
	Mounting	1 Single; 2 Double; W Wall			
	Cylinder	CL Clear long; FL[1] ½ Frosted Long; CT Clear Tapered			
	Light Engine	5G150[2] 1556lm, 15W; 5G250[2] 2477lm, 24W; 5G350 3468lm, 33W; 5G450 4459lm,42W			
	Power Cord Length	8 8′; 10 10′; 12 12′; 14 14′; 16 16′; 18 18′; XX[3] XX′			
	CCT	30 3000K; 40 4000K			
	Finish	WH White; BK Black; BL Semi-Matte Black; BZ Bronze; SV Silver; SP Specify Premium Color			
	Voltage	120; 208; 240; 277; 347[4,5]; 480[4,5]			
	Options	DM Dimming (0-10V); HL30[6,7] Hi-Lo Switching 30-100%; HL50[6,7] Hi-Lo Switching 50-100%; HS* House Side Shield			

[1] DB optics only
[2] Not Available with DM, HL30, or HL50
* Based on R2 distribution and 3000K CCT
[3] Add length of arm + height of pole to determine power cord length
for other CCT please consult factory
[4] Not available with HL30 or HL50
[5] Requires stepdown transformer, 60 Hz only
[6] 120, 240, and 277V Only
[7] Not available with DM option
* Not available with RSS, R5R, or DB optics

Product Modifications

Please list modification requirements for review by factory:

Straight arm, power receptacle hidden in base - one circuit per pole

Approvals

Date:

IP65

Selux Corporation © 2019, T 845-834-1400, 800-735-8927, F 845-834-1401, www.selux.us
In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. Specification sheets found at www.selux.us are the most recent versions and supercede all other printed or electronic versions.

Lighting Notes:

1. Finish to be confirmed by architect.
2. Contractor to coordinate pole mounting with civil scope and other services according to manufacturer recommendations.
3. Modifications include (a) Straight Arms (b) power receptacles hidden in base (c) one circuit per pole.
4. Landscape Architect to Specify Base Cover.
5. Height of pole to be 14’.
6. Refer to Landscape Architect’s drawing to determine single or double mount.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

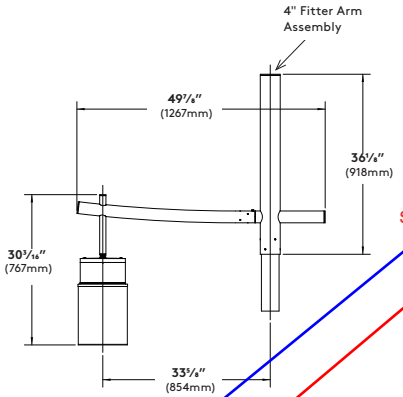
Remove page

Remove page

Lanova LED

selux

Type:
ALP01



straight arm

Net Weight (19.5 lbs)
EPA = 0.68 ft²

Specifications

Luminaire Housing
Die cast aluminum housing made from low copper marine grade aluminum.

Gasketing
(not shown) Continuous UV resistant silicone gasket provides weatherproofing, dust and insect control at all fixture connections.

LED Array
(not shown) High Flux LEDs mounted to metal core PCB and attached to aluminum heat sink for maximum LED performance and life. CCT tolerance within a 3 step bin and provided with a minimum CRI of 80. LED light engine has a reported lumen maintenance of 93% at 50,000 hours. L70 calculated greater than 100,000 hours.

LED Optics
Clear half frosted, or tapered UV stabilized acrylic outer cylinder creates the optical chamber. Technical Optics (R1, R2, R3, R4, R5S and R5R) use Selux signature light pattern acrylic lens holder to secure proprietary silicone optics. Diffuser Bowl (DB) option made of highly diffuse UV stabilized acrylic hides LED source and provides a pleasant/soft light quality.

LED Driver
LEDs are driven by RoHS compliant constant current programmable LED driver. Driver includes 0-10V dimming to 10%, meets the requirements of IP65 and includes a 5 Year warranty.

Surge Protector
(not shown) Independent surge protector device designed to protect luminaire from electrical surge up to 20kA.

Power Cord
(not shown) UV resistant black SJ power cord pre-installed at factory. Please specify power cord length available in 1' increments from 5' – 30'.

Standard exterior colors are White (WH), Black (BK), Semi-Matte Black (BL), Bronze (BZ), and Silver (SV). Selux premium colors (SP) are available, please specify from your Selux color selection guide.

5 Year Limited LED Luminaire Warranty - Selux offers a 5 Year Limited Warranty to the original purchaser that the Lanova LED luminaire shall be free from defects in material and workmanship for up to five (5) years from date of shipment. This limited warranty covers the LED driver and LED array when installed and operated according to Selux instructions. For details, see "Selux Terms and Condition of Sale."

Listings and Ratings: Luminaire tested to IP65 and LM-79 standards. LEDs tested to LM-80 standards.

Luminaire suitable for ambient temperatures from 40°C (104°F) maximum to -40°C (-40°F) minimum.

NRTL Listed (i.e. UL, CSA)

Visit selux.us for our LED End of Life recycling policy.

Selux Corporation © 2019, T 845-834-1400, 800-735-8927, F 845-834-1401, www.selux.us
In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. Specification sheets found at www.selux.us are the most recent versions and supercede all other printed or electronic versions.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page

Remove page

Lanova LED

selux

Type:

ALP01

Mounting

1 - Single Arm

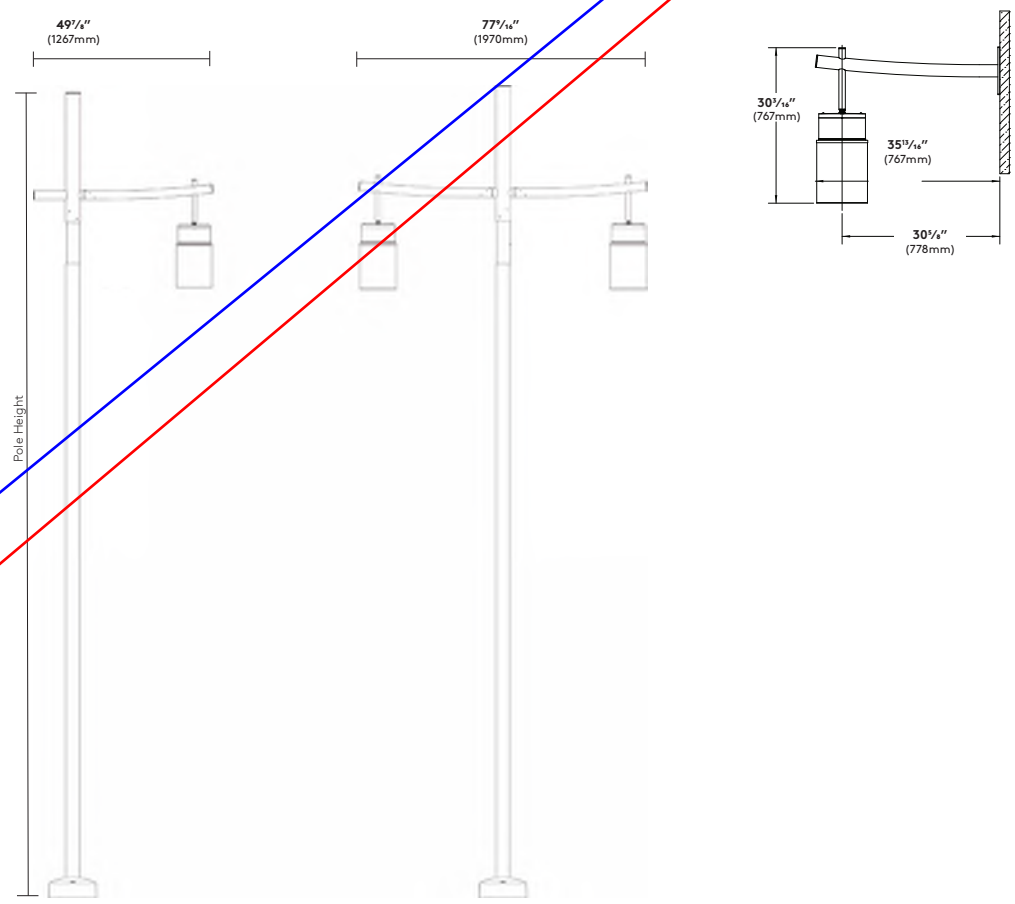
EPA = 1.57ft²
Weight = 32lbs. (15kg)

2 - Double Arm

EPA = 1.3ft²
Weight = 55lbs. (25kg)

W - Wall Mount Arm

EPA = N/A
Weight = 24lbs. (11kg)



Selux Corporation © 2019, T 845-834-1400, 800-735-8927, F 845-834-1401, www.selux.us
In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. Specification sheets found at www.selux.us are the most recent versions and supercede all other printed or electronic versions.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page Remove page

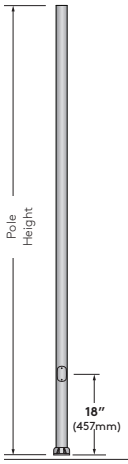
Lanova LED

selux

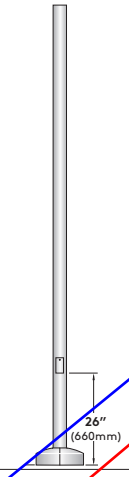
Type:
ALP01

Pole Information
Refer to pole specification sheets for construction details, anchorage information and additional options.

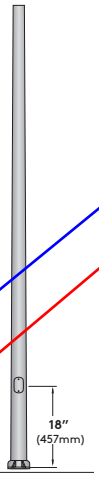
A35/S35 Round Straight Aluminum Pole



A40 Round Straight Aluminum Pole

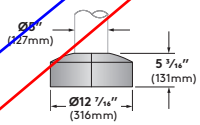


AT535/AT64/AT74 Tapered Aluminum Pole

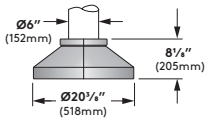


Optional Base Covers for Poles
Die cast aluminum.

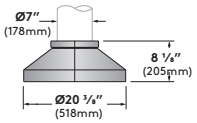
BC3 Optional Base Cover (AT535)
Die cast aluminum, two-piece field installable base cover.



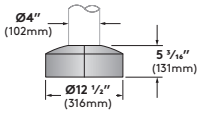
BC9 Optional Base Cover (AT64)
Die cast aluminum, two-piece field installable base cover.



BC10 Optional Base Cover (AT74)
Die cast aluminum, two-piece field installable base cover.



BC13 Optional Base Cover (A40)
Die cast aluminum, two-piece field installable base cover.



Pole Data Chart

Pole Series	Bolt Circle	90 mph	100 mph	110 mph	120 mph	130 mph	140 mph	150 mph	160 mph	170 mph	180 mph	Height	Finish	Options
A35 3½" Round Straight Aluminum Pole	7¼"	4.8	3.5	2.6	1.8	1.3	0.9	0.7	0.6	-	-	**12** 12ft	**WH** White **BK** Black **BL** Semi-Matte Black **BZ** Bronze **SV** Silver **SP** Specify Premium Color	**BC3** Decorative Cast Aluminium Base Cover (AT535) **BC9** Decorative Cast Aluminium Base Cover (AT64) **BC10** Decorative Cast Aluminium Base Cover (AT74) **BC13** Decorative Cast Aluminium Base Cover (A40) **T35** Supplied with 3½" diameter tenon, 4½" high (use for A40, AT64, AT74 only) **REC1** GFCI Receptacle with weather-proof cover **REC2** GFCI Receptacle with weather-proof padlockable in-use cover **REC3** USB and Duplex Receptacle with weather-proof cover **REC4** USB and Duplex Receptacle with weather-proof padlockable in-use cover Motion Sensor w/ Optional Photocell
A40 4" Round straight Aluminum Pole	7½"	9.3	7.2	5.6	4.5	3.7	3.1	2.7	2.3	2.0	1.7			
AT535 5" to 3½" Round Tapered Aluminum Pole	8⅛"	13.4	10.5	8.4	6.9	5.8	4.9	4.2	3.6	3.2	2.8			
AT64 6" to 4" Round Tapered Aluminum Pole	9½"	20.3	16.1	13.1	10.9	9.2	7.9	6.8	5.9	5.2	4.5			
A35 3½" Round Straight Aluminum Pole	7¼"	3.5	2.4	1.6	1.0	0.5	-	-	-	-	-	**14** 14ft		
A40 4" Round sraight Aluminum Pole	7½"	10.3	7.9	6.1	4.9	4.0	3.4	2.9	2.5	2.1	1.8			
AT535 5" to 3½" Round Tapered Aluminum Pole	8⅛"	11.2	8.7	6.9	5.5	4.6	3.8	3.3	2.8	2.4	2.1			
AT64 6" to 4" Round tapered Aluminum Pole	9½"	17.2	13.6	11.0	9.1	7.6	6.5	5.6	4.8	4.2	3.7			
A35 3½" Round Straight Aluminum Pole	7¼"	2.1	1.2	0.6	-	-	-	-	-	-	-	**16** 16ft		
A40 4" Round sraight Aluminum Pole	7½"	8.3	6.2	4.7	3.6	3.0	2.5	2.1	1.7	1.5	1.2			
AT535 5" to 3½" Round tapered Aluminum Pole	8⅛"	9.1	6.9	5.4	4.3	3.4	2.9	2.4	2.0	1.7	1.5			
AT64 6" to 4" Round tapered Aluminum Pole	9½"	14.3	11.2	9.0	7.4	6.2	5.2	4.4	3.8	3.3	2.9			
A40 4" Round sraight Aluminum Pole	7½"	6.6	4.8	3.5	2.6	2.1	1.7	1.4	1.1	0.9	0.7	**18** 18ft		
AT535 5" to 3½" Round tapered Aluminum Pole	8⅛"	9.2	7.0	5.4	4.2	3.4	2.8	2.3	2.0	1.7	1.4			
AT64 6" to 4" Round tapered Aluminum Pole	9½"	11.9	9.2	7.3	6.0	4.9	4.2	3.5	3.0	2.6	2.2			
AT74 7" to 4" Round tapered Aluminum Pole	10⅝"	17.5	13.8	11.2	9.2	7.7	6.5	5.6	4.8	4.1	3.5			

Allowable EPA calculated according to AASHTO 1994 and include allowance for 1/3 gust factor. See Mounting Configuration pages for fixture arm weight and EPA values.

Selux Corporation © 2019, T 845-834-1400, 800-735-8927, F 845-834-1401, www.selux.us
In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. Specification sheets found at www.selux.us are the most recent versions and supercede all other printed or electronic versions.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page

Remove page

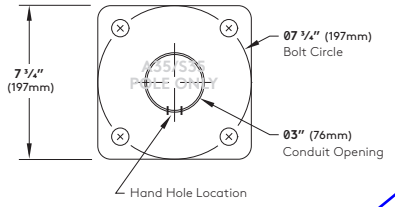
Lanova LED

selux

Type:
ALP01

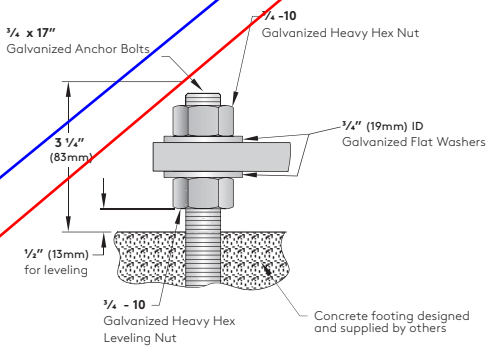
Pole Information
Refer to pole specification sheets for construction details, anchorage information and additional options.

Bolt Circle for A35 & S35
Use caution when setting anchor bolts. Bolts must be vertically straight and centered on dimensions shown

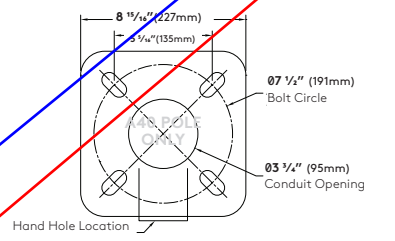


Note: Adequate drainage must be provided in concrete foundation.

Anchor Bolt Detail for A35 & S35

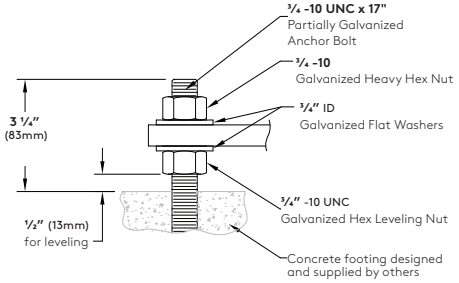


Bolt Circle for A40
Use caution when setting anchor bolts. Bolts must be vertically straight and centered on dimensions shown

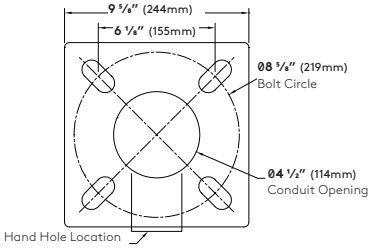


Note: Adequate drainage must be provided in concrete foundation.

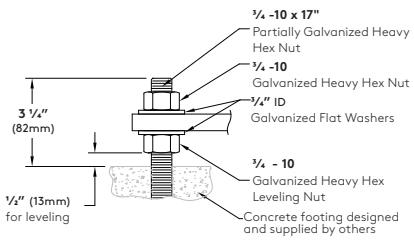
Anchor Bolt Detail for A40



Bolt Circle for AT535
Use caution when setting anchor bolts. Bolts must be vertically straight and centered on dimensions shown



Anchor Bolt Detail for AT535



Selux Corporation © 2019, T 845-834-1400, 800-735-8927, F 845-834-1401, www.selux.us
In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. Specification sheets found at www.selux.us are the most recent versions and supercede all other printed or electronic versions.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page

Remove page

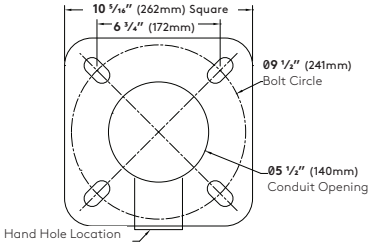
Lanova LED

selux

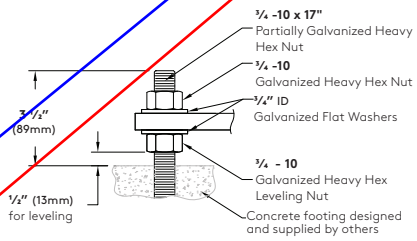
Type:
ALP01

Pole Information
Refer to pole specification sheets for construction details, anchorage information and additional options.

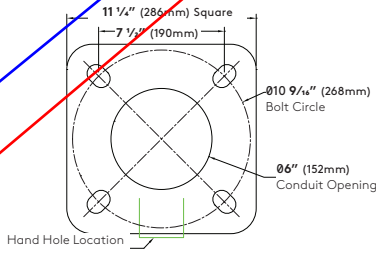
Bolt Circle for AT64
Use caution when setting anchor bolts. Bolts must be vertically straight and centered on dimensions shown



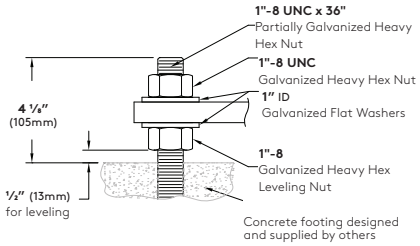
Anchor Bolt Detail for AT64



Bolt Circle for AT74
Use caution when setting anchor bolts. Bolts must be vertically straight and centered on dimensions shown



Anchor Bolt Detail for AT74



Selux Corporation © 2019, T 845-834-1400, 800-735-8927, F 845-834-1401, www.selux.us
In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. Specification sheets found at www.selux.us are the most recent versions and supercede all other printed or electronic versions.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Manufacturer: Selux : Lenova LED Pole Mount
Description: 14ft Pole Light R1 Type Distribution

Fixture Wattage: 24 W
Lumen Output: 2477 lumen
Lamp CRI: 80+
Lighting Controls: 0-10V Dimming

Voltage: 120 V
Fixture Finish: Dark Grey
Lamp CCT: 2700K
Assembly Code: LAL-R1-X-CL-5G250-XX-30-SP-120-DM-MOD

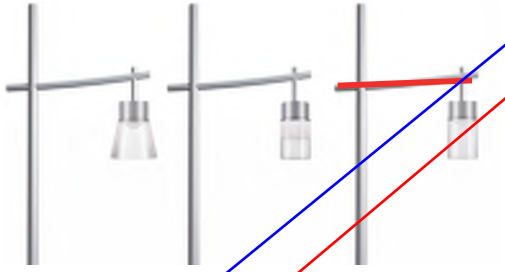
Date: _____ Customer: _____

Project: _____

Type: _____ Qty: _____

selux

Lanova LED Pole Mount



Order Code: LAL - ____ - ____ - ____ - ____ - ____ - ____ - ____ - ____ - ____ - ____

Pole Order Code: ____ - ____ - ____ - ____

		Series	Height	Finish	Options

LAL	Series	LAL Lanova LED							
	Optics	R1 Type I Distribution	R2 Type II Distribution	R3 Type III Distribution	R4 Type IV Distribution	R5S Type V Square	R5R Type V Round	DB Diffuse Bowl	
	Mounting	1 Single	2 Double	W Wall					
	Cylinder	CL Clear long	FL[1] ½ Frosted Long	CT Clear Tapered					[1] DB optics only
	Light Engine	5G150[2] 1556lm, 15W	5G250[2] 2477lm, 24W	5G350 3468lm, 33W	5G450 4459lm,42W				[2] Not Available with DM, HL30, or HL50 * Based on R2 distribution and 3000K CCT
	Power Cord Length	8 8′	10 10′	12 12′	14 14′	16 16′	18 18′	XX[3] XX′	[3] Add length of arm + height of pole to determine power cord length
	CCT	30 3000K	40 4000K						for other CCT please consult factory
	Finish	WH White	BK Black	BL Semi-Matte Black	BZ Bronze	SV Silver	SP Specify Premium Color		
	Voltage	120	208	240	277	347[4,5]	480[4,5]		[4] Not available with HL30 or HL50 [5] Requires stepdown transformer, 60 Hz only
	Options	DM Dimming (0-10V)	HL30[6,7] Hi-Lo Switching 30-100%	HL50[6,7] Hi-Lo Switching 50-100%	HS* House Side Shield				[6] 120, 240, and 277V Only [7] Not available with DM option * Not available with RSS, RSR, or DB optics

Product Modifications

Please list modification requirements for review by factory:

Straight arm, power receptacle hidden in base - one circuit per pole

Approvals

Date:

NRTL WET IP65 UNION MADE

Selux Corporation © 2019, T 845-834-1400, 800-735-8927, F 845-834-1401, www.selux.us
In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. Specification sheets found at www.selux.us are the most recent versions and supercede all other printed or electronic versions.

Type:
ALP02

Lighting Notes:

1. Finish to be confirmed by architect.
2. Contractor to coordinate pole mounting with civil scope and other services according to manufacturer recommendations.
3. Modifications include (a) Straight Arms (b) power receptacles hidden in base (c) one circuit per pole.
4. Landscape Architect to Specify Base Cover.
5. Height of pole to be 14’.
6. Refer to drawing to determine single or double mount.
7. Add alternate: Standard Finish

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page

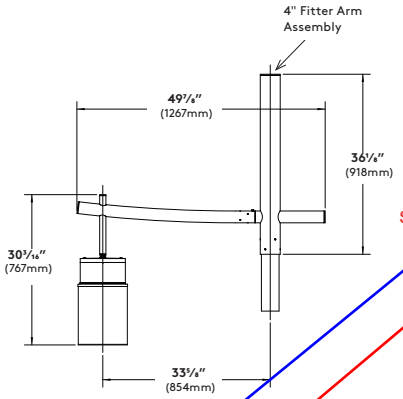
Remove page

Lanova LED

selux

Type:

ALP02



straight arm

Net Weight (19.5 lbs)
EPA = 0.68 ft²

Specifications

Luminaire Housing
Die cast aluminum housing made from low copper marine grade aluminum.

Gasketing
(not shown) Continuous UV resistant silicone gasket provides weatherproofing, dust and insect control at all fixture connections.

LED Array
(not shown) High Flux LEDs mounted to metal core PCB and attached to aluminum heat sink for maximum LED performance and life. CCT tolerance within a 3 step bin and provided with a minimum CRI of 80. LED light engine has a reported lumen maintenance of 93% at 50,000 hours. L70 calculated greater than 100,000 hours.

LED Optics
Clear half frosted, or tapered UV stabilized acrylic outer cylinder creates the optical chamber. Technical Optics (R1, R2, R3, R4, R5S and R5R) use Selux signature light pattern acrylic lens holder to secure proprietary silicone optics. Diffuser Bowl (DB) option made of highly diffuse UV stabilized acrylic hides LED source and provides a pleasant/soft light quality.

LED Driver
LEDs are driven by RoHS compliant constant current programmable LED driver. Driver includes 0-10V dimming to 10%, meets the requirements of IP65 and includes a 5 Year warranty.

Surge Protector
(not shown) Independent surge protector device designed to protect luminaire from electrical surge up to 20kA.

Power Cord
(not shown) UV resistant black SJ power cord pre-installed at factory. Please specify power cord length available in 1' increments from 5' – 30'.

Standard exterior colors are White (WH), Black (BK), Semi-Matte Black (BL), Bronze (BZ), and Silver (SV). Selux premium colors (SP) are available, please specify from your Selux color selection guide.

5 Year Limited LED Luminaire Warranty - Selux offers a 5 Year Limited Warranty to the original purchaser that the Lanova LED luminaire shall be free from defects in material and workmanship for up to five (5) years from date of shipment. This limited warranty covers the LED driver and LED array when installed and operated according to Selux instructions. For details, see "Selux Terms and Condition of Sale."

Listings and Ratings: Luminaire tested to IP65 and LM-79 standards. LEDs tested to LM-80 standards.

Luminaire suitable for ambient temperatures from 40°C (104°F) maximum to -40°C (-40°F) minimum.

NRTL Listed (i.e. UL, CSA)

Visit selux.us for our LED End of Life recycling policy.

Selux Corporation © 2019, T 845-834-1400, 800-735-8927, F 845-834-1401, www.selux.us
In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. Specification sheets found at www.selux.us are the most recent versions and supercede all other printed or electronic versions.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page Remove page

Lanova LED

Mounting

selux

Type:
ALP02

1 - Single Arm

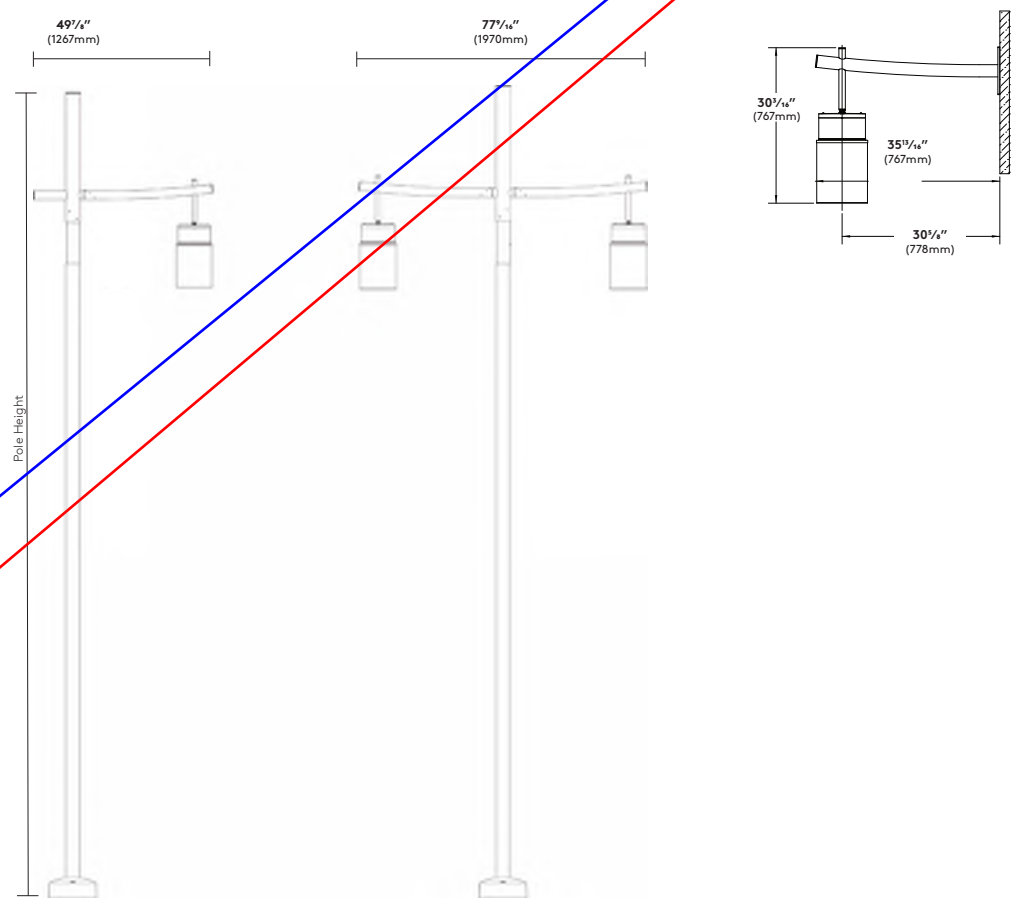
EPA = 1.57ft²
Weight = 32lbs. (15kg)

2 - Double Arm

EPA = 1.3ft²
Weight = 55lbs. (25kg)

W - Wall Mount Arm

EPA = N/A
Weight = 24lbs. (11kg)



Selux Corporation © 2019, T 845-834-1400, 800-735-8927, F 845-834-1401, www.selux.us
In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. Specification sheets found at www.selux.us are the most recent versions and supercede all other printed or electronic versions.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

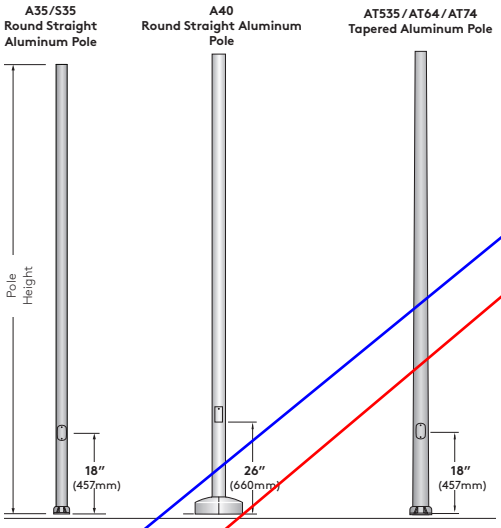
Remove page Remove page

Lanova LED

selux

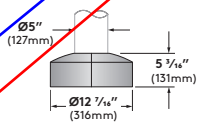
Type:
ALP02

Pole Information
Refer to pole specification sheets for construction details, anchorage information and additional options.

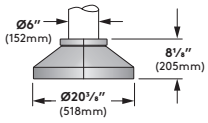


Optional Base Covers for Poles
Die cast aluminum.

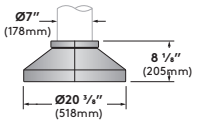
BC3 Optional Base Cover (AT535)
Die cast aluminum, two-piece field installable base cover.



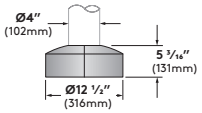
BC9 Optional Base Cover (AT64)
Die cast aluminum, two-piece field installable base cover.



BC10 Optional Base Cover (AT74)
Die cast aluminum, two-piece field installable base cover.



BC13 Optional Base Cover (A40)
Die cast aluminum, two-piece field installable base cover.



Pole Data Chart

Pole Series	Bolt Circle	90 mph	100 mph	110 mph	120 mph	130 mph	140 mph	150 mph	160 mph	170 mph	180 mph	Height	Finish	Options
A35 3½" Round Straight Aluminum Pole	7¼"	4.8	3.5	2.6	1.8	1.3	0.9	0.7	0.6	-	-	**12** 12ft	**WH** White **BK** Black **BL** Semi-Matte Black **BZ** Bronze **SV** Silver **SP** Specify Premium Color	**BC3** Decorative Cast Aluminium Base Cover (AT535) **BC9** Decorative Cast Aluminium Base Cover (AT64) **BC10** Decorative Cast Aluminium Base Cover (AT74) **BC13** Decorative Cast Aluminium Base Cover (A40) **T35** Supplied with 3½" diameter tenon, 4½" high (use for A40, AT64, AT74 only) **REC1** GFCI Receptacle with weather-proof cover **REC2** GFCI Receptacle with weather-proof padlockable in-use cover **REC3** USB and Duplex Receptacle with weather-proof cover **REC4** USB and Duplex Receptacle with weather-proof padlockable in-use cover Motion Sensor w/ Optional Photocell
A40 4" Round Straight Aluminum Pole	7½"	9.3	7.2	5.6	4.5	3.7	3.1	2.7	2.3	2.0	1.7			
AT535 5" to 3½" Round Tapered Aluminum Pole	8⅛"	13.4	10.5	8.4	6.9	5.8	4.9	4.2	3.6	3.2	2.8			
AT64 6" to 4" Round Tapered Aluminum Pole	9½"	20.3	16.1	13.1	10.9	9.2	7.9	6.8	5.9	5.2	4.5			
A35 3½" Round Straight Aluminum Pole	7¼"	3.5	2.4	1.6	1.0	0.5	-	-	-	-	-	**14** 14ft		
A40 4" Round sraight Aluminum Pole	7½"	10.3	7.9	6.1	4.9	4.0	3.4	2.9	2.5	2.1	1.8			
AT535 5" to 3½" Round Tapered Aluminum Pole	8⅛"	11.2	8.7	6.9	5.5	4.6	3.8	3.3	2.8	2.4	2.1			
AT64 6" to 4" Round tapered Aluminum Pole	9½"	17.2	13.6	11.0	9.1	7.6	6.5	5.6	4.8	4.2	3.7			
A35 3½" Round Straight Aluminum Pole	7¼"	2.1	1.2	0.6	-	-	-	-	-	-	-	**16** 16ft		
A40 4" Round sraight Aluminum Pole	7½"	8.3	6.2	4.7	3.6	3.0	2.5	2.1	1.7	1.5	1.2			
AT535 5" to 3½" Round tapered Aluminum Pole	8⅛"	9.1	6.9	5.4	4.3	3.4	2.9	2.4	2.0	1.7	1.5			
AT64 6" to 4" Round tapered Aluminum Pole	9½"	14.3	11.2	9.0	7.4	6.2	5.2	4.4	3.8	3.3	2.9			
A40 4" Round sraight Aluminum Pole	7½"	6.6	4.8	3.5	2.6	2.1	1.7	1.4	1.1	0.9	0.7	**18** 18ft		
AT535 5" to 3½" Round tapered Aluminum Pole	8⅛"	9.2	7.0	5.4	4.2	3.4	2.8	2.3	2.0	1.7	1.4			
AT64 6" to 4" Round tapered Aluminum Pole	9½"	11.9	9.2	7.3	6.0	4.9	4.2	3.5	3.0	2.6	2.2			
AT74 7" to 4" Round tapered Aluminum Pole	10⅝"	17.5	13.8	11.2	9.2	7.7	6.5	5.6	4.8	4.1	3.5			

Allowable EPA calculated according to AASHTO 1994 and include allowance for 1/3 gust factor. See Mounting Configuration pages for fixture arm weight and EPA values.

Selux Corporation © 2019, T 845-834-1400, 800-735-8927, F 845-834-1401, www.selux.us
In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. Specification sheets found at www.selux.us are the most recent versions and supercede all other printed or electronic versions.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page Remove page

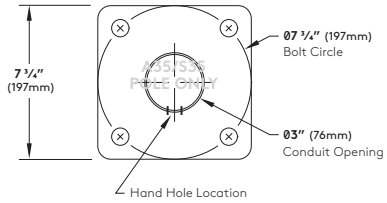
Lanova LED

selux

Type:
ALP02

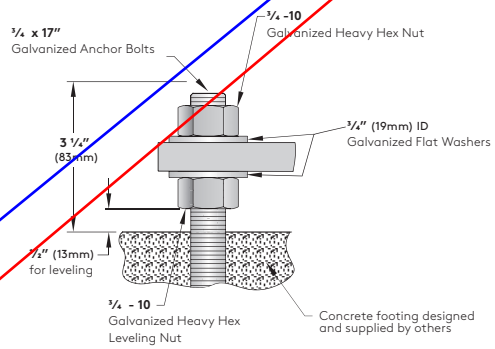
Pole Information
Refer to pole specification sheets for construction details, anchorage information and additional options.

Bolt Circle for A35 & S35
Use caution when setting anchor bolts. Bolts must be vertically straight and centered on dimensions shown

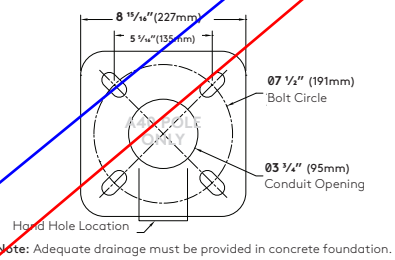


Note: Adequate drainage must be provided in concrete foundation.

Anchor Bolt Detail for A35 & S35

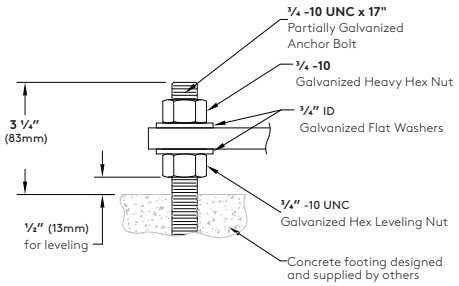


Bolt Circle for A40
Use caution when setting anchor bolts. Bolts must be vertically straight and centered on dimensions shown

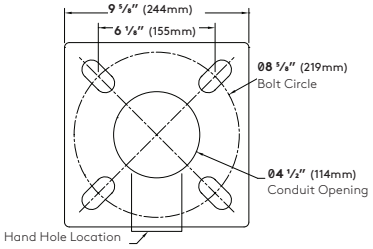


Note: Adequate drainage must be provided in concrete foundation.

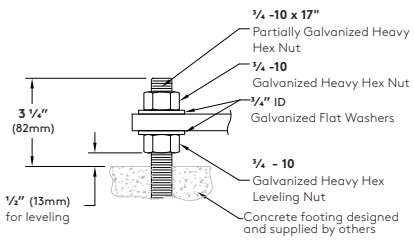
Anchor Bolt Detail for A40



Bolt Circle for AT535
Use caution when setting anchor bolts. Bolts must be vertically straight and centered on dimensions shown



Anchor Bolt Detail for AT535



Selux Corporation © 2019, T 845-834-1400, 800-735-8927, F 845-834-1401, www.selux.us
In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. Specification sheets found at www.selux.us are the most recent versions and supercede all other printed or electronic versions.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page Remove page

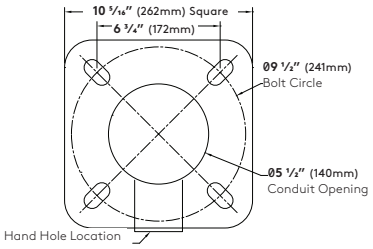
Lanova LED

selux

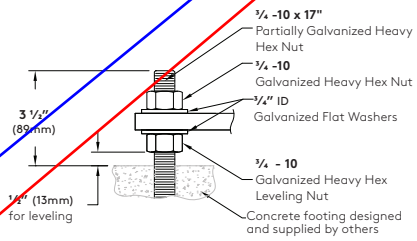
Type:
ALP02

Pole Information
Refer to pole specification sheets for construction details, anchorage information and additional options.

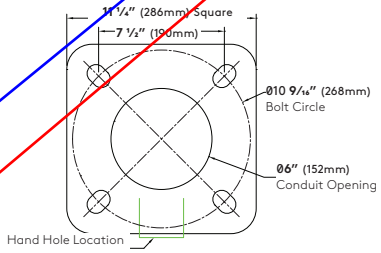
Bolt Circle for AT64
Use caution when setting anchor bolts. Bolts must be vertically straight and centered on dimensions shown



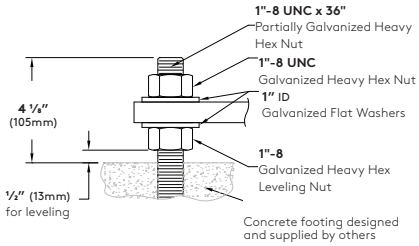
Anchor Bolt Detail for AT64



Bolt Circle for AT74
Use caution when setting anchor bolts. Bolts must be vertically straight and centered on dimensions shown



Anchor Bolt Detail for AT74



Selux Corporation © 2019, T 845-834-1400, 800-735-8927, F 845-834-1401, www.selux.us
In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. Specification sheets found at www.selux.us are the most recent versions and supercede all other printed or electronic versions.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page

Remove page

Lanova LED

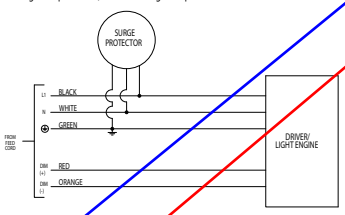
selux

Type:
ALP02

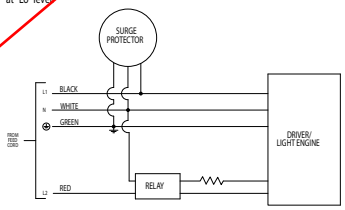
ELECTRICAL SPECIFICATIONS									
CCT	3000K/4000K								
CYLINDER	CL Cylinder Standard						FL Cylinder Standard		
OPTICS	R1, R2, R3, and R4			R5R and R5S			DB		
Light Engine/ Electrical Specs	Delivered Lumens (lm)	Wattage (W) 120-277 / 347-480	Efficacy (lm/W)	Delivered Lumens (lm)	Wattage (W) 120-277 / 347-480	Efficacy (lm/W)	Delivered Lumens (lm)	Wattage (W) 120-277 / 347-480	Efficacy (lm/W)
5G150	1316	14.2 / 18	92.9	1488	14.2 / 18	105.0	1327	14.2 / 18	93.5
5G250	2193	23.6 / 27	92.9	2480	23.6 / 27	105.0	2211	23.6 / 27	93.5
5G350	3070	33.1 / 35	92.9	3471	33.1 / 35	105.0	3096	33.1 / 35	93.5
5G450	3948	42.5 / 44	92.9	4463	42.5 / 44	105.0	3981	42.5 / 44	93.5

Wiring

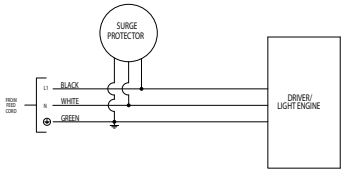
0-10V Dimming Option (DM) Wiring for 120-277V
100% light output at 10V, down to 1% light output at 0V.



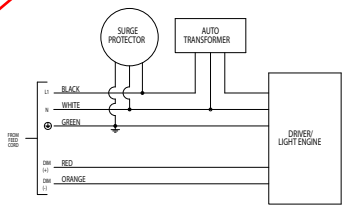
Hi-Lo Switching Option (HL30/HL50) Wiring
120/240/277V. When red is energized, light output will be at "Lo" level.



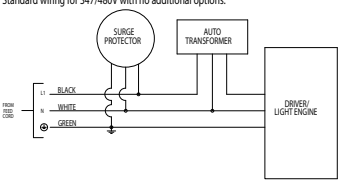
Standard Wiring for 120-277V
Standard wiring for 120-277V with no additional options.



0-10V Dimming Option (DM) Wiring for 347/480V
100% light output at 10V, down to 1% light output at 0V.



Standard Wiring for 347/480V
Standard wiring for 347/480V with no additional options.



Selux Corporation © 2019, T 845-834-1400, 800-735-8927, F 845-834-1401, www.selux.us
In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. Specification sheets found at www.selux.us are the most recent versions and supercede all other printed or electronic versions.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page Remove page

Lanova LED

selux

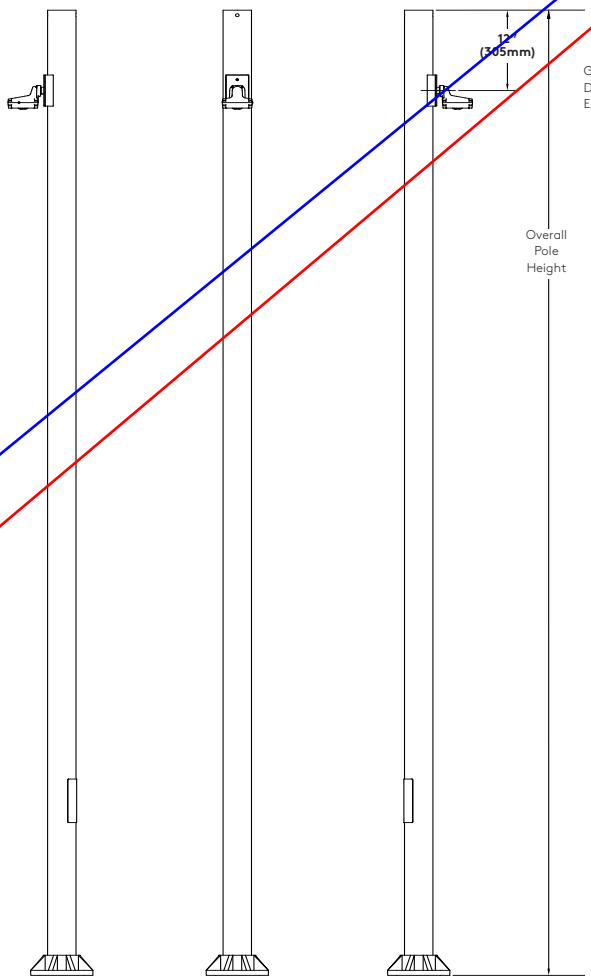
Type:
ALP02

Pole Motion Sensor

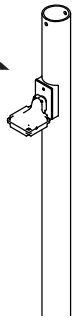
The Selux outdoor rated sensor incorporates Passive Infrared (PIR) technology for motion sensing and also includes a built in photocell. Designed to mount directly through a 1/2" KO in a single gang faceplate on pole/column, the SBO utilizes 100% Digital Passive Infrared (PIR) technology that is tuned for walking size while preventing false tripping from the environment.

Series	Optics	Hand Hole Orientation	Program	Color	Photocell Feature	Voltage
MS Motion Sensor	**1** 270° coverage - Single Sensor	**00**	**D0** (0V=0%)	**WH** White	**Y** Yes	**UNV**
		09	**D1** (1V=10%)	**BK** Black	**N** No	**347**
		18	**D3** (3V=30%)	**BZ** Bronze		**480**
		27	**D5** (5V=50%)			

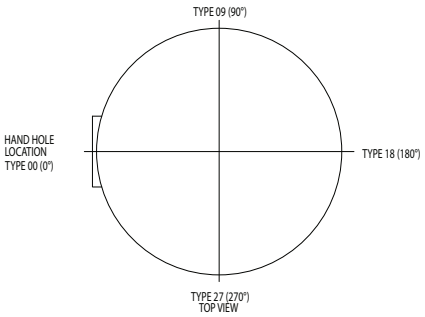
NOTE: Motion sensor comes programmed at 30% dimmed level with a 5 min. delay as default. All programming required after shipping by others.



General Pole Drawing For Example Only



Sensor angular orientation from hand hole 0°
90° increments clockwise around pole (Type 00,09,18,27)



Selux Corporation © 2019, T 845-834-1400, 800-735-8927, F 845-834-1401, www.selux.us
In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. Specification sheets found at www.selux.us are the most recent versions and supercede all other printed or electronic versions.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page

Remove page

Manufacturer: Selux : Lenova LED Pole Mount
Description: 14ft Pole Light R5R Type Distribution

Fixture Wattage: 24 W
Lumen Output: 2477 lumen
Lamp CRI: 80+
Lighting Controls: 0-10V Dimming

Voltage: 120 V
Fixture Finish: Dark Grey
Lamp CCT: 2700K
Assembly Code: LAL-R5R-X-CL-5G250-XX-30-SP-120-DM-MOD

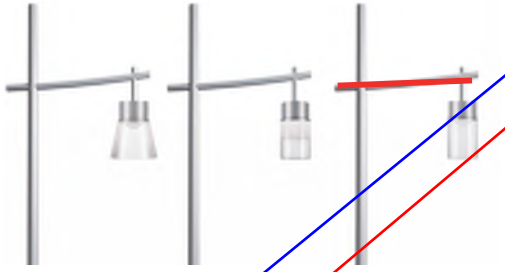
Date: _____ Customer: _____

Project: _____

Type: _____ Qty: _____

selux

Lanova LED Pole Mount



straight arm

Order Code: LAL - ____ - ____ - ____ - ____ - ____ - ____ - ____ - ____ - ____ - ____

Pole Order Code: ____ - ____ - ____ - ____

LAL	Series	LAL Lanova LED							Series
	Optics	R1 Type I Distribution	R2 Type II Distribution	R3 Type III Distribution	R4 Type IV Distribution	R5S Type V Square	R5R Type V Round	DB Diffuse Bowl	Height
	Mounting	1 Single	2 Double	W Wall					Finish
	Cylinder	CL Clear long	FL[1] ½ Frosted Long	CT Clear Tapered					Options
	Light Engine	5G150[2] 1556lm, 15W	5G250[2] 2477lm, 24W	5G350 3468lm, 33W	5G450 4459lm,42W				
	Power Cord Length	8 8′	10 10′	12 12′	14 14′	16 16′	18 18′	XX[3] XX′	
	CCT	30 3000K	40 4000K						
	Finish	WH White	BK Black	BL Semi-Matte Black	BZ Bronze	SV Silver	SP Specify Premium Color		
	Voltage	120	208	240	277	347[4,5]	480[4,5]		
	Options	DM Dimming (0-10V)	HL30[6,7] Hi-Lo Switching 30-100%	HL50[6,7] Hi-Lo Switching 50-100%	HS* House Side Shield				

[1] DB optics only

[2] Not Available with DM, HL30, or HL50
* Based on R2 distribution and 3000K CCT

[3] Add length of arm + height of pole to determine power cord length

for other CCT please consult factory

[4] Not available with HL30 or HL50
[5] Requires stepdown transformer, 60 Hz only

[6] 120, 240, and 277V Only
[7] Not available with DM option
* Not available with RSS, R5R, or DB optics

Product Modifications

Please list modification requirements for review by factory:

Straight arm, power receptacle hidden in base - one circuit per pole

Approvals

Date:

NRTL WET IP65 UNION MADE

Selux Corporation © 2019, T 845-834-1400, 800-735-8927, F 845-834-1401, www.selux.us
In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. Specification sheets found at www.selux.us are the most recent versions and supercede all other printed or electronic versions.

Type:
ALP03

Lighting Notes:

1. Finish to be confirmed by architect.
2. Contractor to coordinate pole mounting with civil scope and other services according to manufacturer recommendations.
3. Modifications include (a) Straight Arms (b) power receptacles hidden in base (c) one circuit per pole.
4. Landscape Architect to Specify Base Cover.
5. Height of pole to be 14’.
6. Refer to drawing to determine single or double mount.
7. Add alternate: Standard Finish

ARUP
Project Number: 271565
Phone: 1 212 896 3000

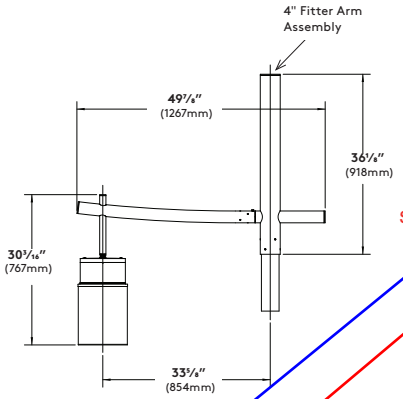
Remove page

Remove page

Lanova LED

selux

Type:
ALP03



straight arm

Net Weight (19.5 lbs)
EPA = 0.68 ft²

Specifications

Luminaire Housing
Die cast aluminum housing made from low copper marine grade aluminum.

Gasketing
(not shown) Continuous UV resistant silicone gasket provides weatherproofing, dust and insect control at all fixture connections.

LED Array
(not shown) High Flux LEDs mounted to metal core PCB and attached to aluminum heat sink for maximum LED performance and life. CCT tolerance within a 3 step bin and provided with a minimum CRI of 80. LED light engine has a reported lumen maintenance of 93% at 50,000 hours. L70 calculated greater than 100,000 hours.

LED Optics
Clear half frosted, or tapered UV stabilized acrylic outer cylinder creates the optical chamber. Technical Optics (R1, R2, R3, R4, R5S and R5R) use Selux signature light pattern acrylic lens holder to secure proprietary silicone optics. Diffuser Bowl (DB) option made of highly diffuse UV stabilized acrylic hides LED source and provides a pleasant/soft light quality.

LED Driver
LEDs are driven by RoHS compliant constant current programmable LED driver. Driver includes 0-10V dimming to 10%, meets the requirements of IP65 and includes a 5 Year warranty.

Surge Protector
(not shown) Independent surge protector device designed to protect luminaire from electrical surge up to 20kA.

Power Cord
(not shown) UV resistant black SJ power cord pre-installed at factory. Please specify power cord length available in 1' increments from 5' – 30'.

Standard exterior colors are White (WH), Black (BK), Semi-Matte Black (BL), Bronze (BZ), and Silver (SV). Selux premium colors (SP) are available, please specify from your Selux color selection guide.

5 Year Limited LED Luminaire Warranty - Selux offers a 5 Year Limited Warranty to the original purchaser that the Lanova LED luminaire shall be free from defects in material and workmanship for up to five (5) years from date of shipment. This limited warranty covers the LED driver and LED array when installed and operated according to Selux instructions. For details, see "Selux Terms and Condition of Sale."

Listings and Ratings: Luminaire tested to IP65 and LM-79 standards. LEDs tested to LM-80 standards.

Luminaire suitable for ambient temperatures from 40°C (104°F) maximum to -40°C (-40°F) minimum.

NRTL Listed (i.e. UL, CSA)

Visit selux.us for our LED End of Life recycling policy.

Selux Corporation © 2019, T 845-834-1400, 800-735-8927, F 845-834-1401, www.selux.us
In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. Specification sheets found at www.selux.us are the most recent versions and supercede all other printed or electronic versions.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page Remove page

Lanova LED

selux

Type:
ALP03

Mounting

1 - Single Arm

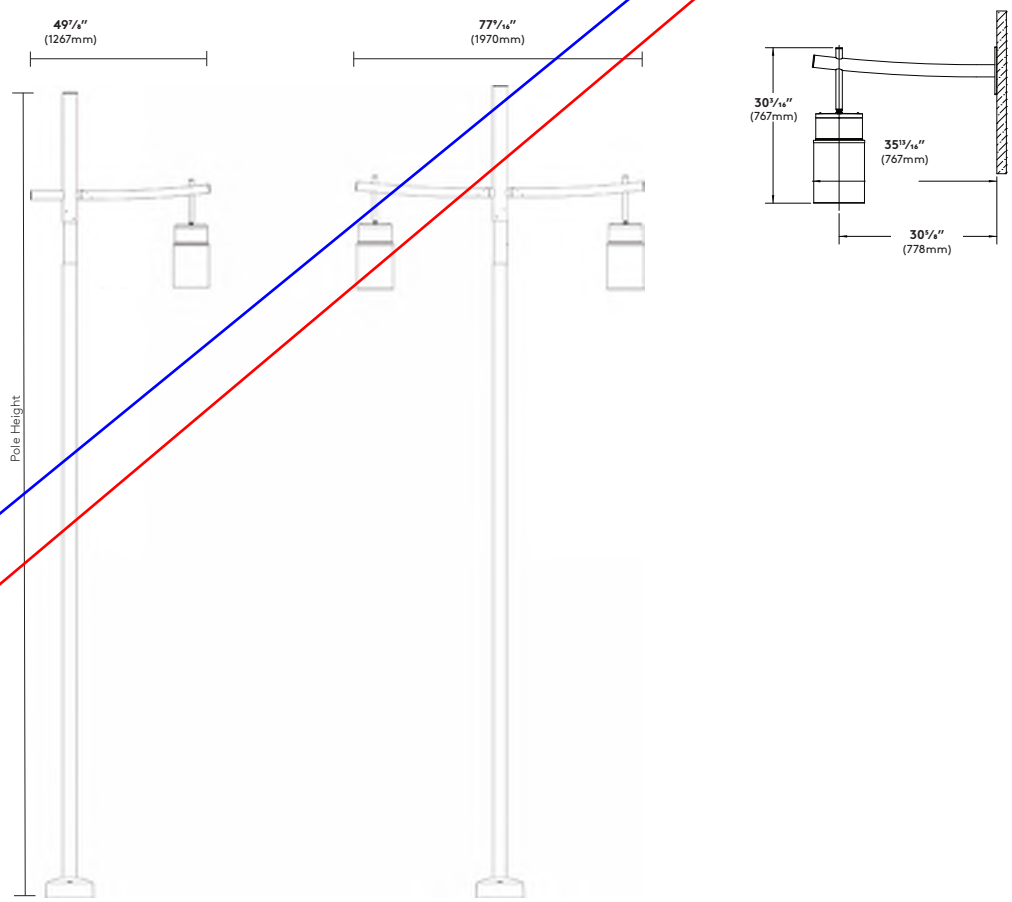
EPA = 1.57ft²
Weight = 32lbs. (15kg)

2 - Double Arm

EPA = 1.3ft²
Weight = 55lbs. (25kg)

W - Wall Mount Arm

EPA = N/A
Weight = 24lbs. (11kg)



Selux Corporation © 2019, T 845-834-1400, 800-735-8927, F 845-834-1401, www.selux.us
In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. Specification sheets found at www.selux.us are the most recent versions and supercede all other printed or electronic versions.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page

Remove page

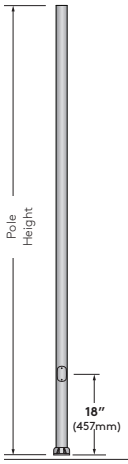
Lanova LED

selux

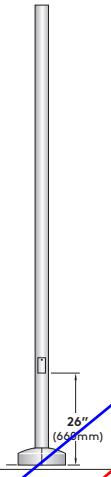
Type:
ALP03

Pole Information
Refer to pole specification sheets for construction details, anchorage information and additional options.

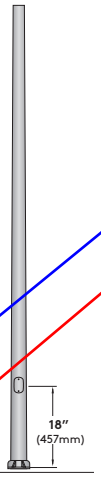
A35/S35 Round Straight Aluminum Pole



A40 Round Straight Aluminum Pole

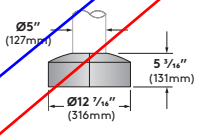


AT535/AT64/AT74 Tapered Aluminum Pole

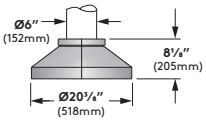


Optional Base Covers for Poles
Die cast aluminum.

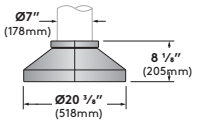
BC3 Optional Base Cover (AT535)
Die cast aluminum, two-piece field installable base cover.



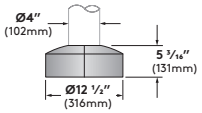
BC9 Optional Base Cover (AT64)
Die cast aluminum, two-piece field installable base cover.



BC10 Optional Base Cover (AT74)
Die cast aluminum, two-piece field installable base cover.



BC13 Optional Base Cover (A40)
Die cast aluminum, two-piece field installable base cover.



Pole Data Chart

Pole Series	Bolt Circle	90 mph	100 mph	110 mph	120 mph	130 mph	140 mph	150 mph	160 mph	170 mph	180 mph	Height
A35 3½" Round Straight Aluminum Pole	7¼"	4.8	3.5	2.6	1.8	1.3	0.9	0.7	0.6	-	-	**12** 12ft
A40 4" Round Straight Aluminum Pole	7½"	9.3	7.2	5.6	4.5	3.7	3.1	2.7	2.3	2.0	1.7	
AT535 5" to 3½" Round Tapered Aluminum Pole	8⅛"	13.4	10.5	8.4	6.9	5.8	4.9	4.2	3.6	3.2	2.8	
AT64 6" to 4" Round Tapered Aluminum Pole	9½"	20.3	16.1	13.1	10.9	9.2	7.9	6.8	5.9	5.2	4.5	
A35 3½" Round Straight Aluminum Pole	7¼"	3.5	2.4	1.6	1.0	0.5	-	-	-	-	-	**14** 14ft
A40 4" Round sraight Aluminum Pole	7½"	10.3	7.9	6.1	4.9	4.0	3.4	2.9	2.5	2.1	1.8	
AT535 5" to 3½" Round Tapered Aluminum Pole	8⅛"	11.2	8.7	6.9	5.5	4.6	3.8	3.3	2.8	2.4	2.1	
AT64 6" to 4" Round tapered Aluminum Pole	9½"	17.2	13.6	11.0	9.1	7.6	6.5	5.6	4.8	4.2	3.7	
A35 3½" Round Straight Aluminum Pole	7¼"	2.1	1.2	0.6	-	-	-	-	-	-	-	**16** 16ft
A40 4" Round sraight Aluminum Pole	7½"	8.3	6.2	4.7	3.6	3.0	2.5	2.1	1.7	1.5	1.2	
AT535 5" to 3½" Round tapered Aluminum Pole	8⅛"	9.1	6.9	5.4	4.3	3.4	2.9	2.4	2.0	1.7	1.5	
AT64 6" to 4" Round tapered Aluminum Pole	9½"	14.3	11.2	9.0	7.4	6.2	5.2	4.4	3.8	3.3	2.9	
A40 4" Round sraight Aluminum Pole	7½"	6.6	4.8	3.5	2.6	2.1	1.7	1.4	1.1	0.9	0.7	**18** 18ft
AT535 5" to 3½" Round tapered Aluminum Pole	8⅛"	9.2	7.0	5.4	4.2	3.4	2.8	2.3	2.0	1.7	1.4	
AT64 6" to 4" Round tapered Aluminum Pole	9½"	11.9	9.2	7.3	6.0	4.9	4.2	3.5	3.0	2.6	2.2	
AT74 7" to 4" Round tapered Aluminum Pole	10⅝"	17.5	13.8	11.2	9.2	7.7	6.5	5.6	4.8	4.1	3.5	

Allowable EPA calculated according to AASHTO 1994 and include allowance for 1/3 gust factor. See Mounting Configuration pages for fixture arm weight and EPA values.

Finish

WH White
BK Black
BL Semi-Matte Black
BZ Bronze
SV Silver
SP Specify Premium Color

Options

BC3 Decorative Cast Aluminium Base Cover (AT535)
BC9 Decorative Cast Aluminium Base Cover (AT64)
BC10 Decorative Cast Aluminium Base Cover (AT74)
BC13 Decorative Cast Aluminium Base Cover (A40)
T35 Supplied with 3½" diameter tenon, 4½" high (use for A40, AT64, AT74 only)
REC1 GFCI Receptacle with weather-proof cover
REC2 GFCI Receptacle with weather-proof padlockable in-use cover
REC3 USB and Duplex Receptacle with weather-proof cover
REC4 USB and Duplex Receptacle with weather-proof padlockable in-use cover
Motion Sensor w/ Optional Photocell

Selux Corporation © 2019, T 845-834-1400, 800-735-8927, F 845-834-1401, www.selux.us
In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. Specification sheets found at www.selux.us are the most recent versions and supercede all other printed or electronic versions.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page Remove page

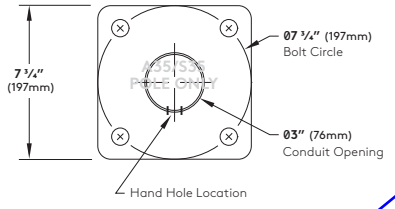
Lanova LED

selux

Type:
ALP03

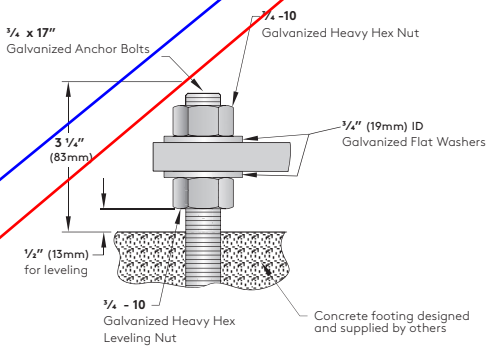
Pole Information
Refer to pole specification sheets for construction details, anchorage information and additional options.

Bolt Circle for A35 & S35
Use caution when setting anchor bolts. Bolts must be vertically straight and centered on dimensions shown

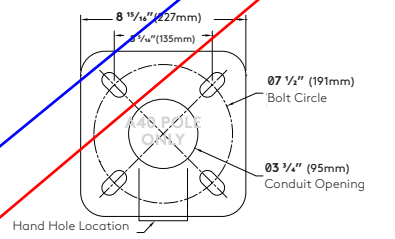


Note: Adequate drainage must be provided in concrete foundation.

Anchor Bolt Detail for A35 & S35

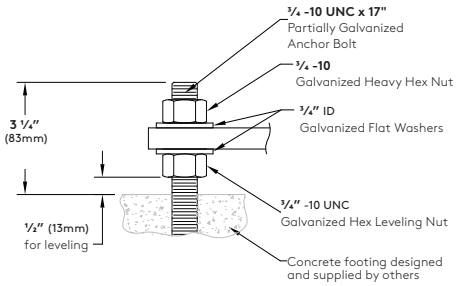


Bolt Circle for A40
Use caution when setting anchor bolts. Bolts must be vertically straight and centered on dimensions shown

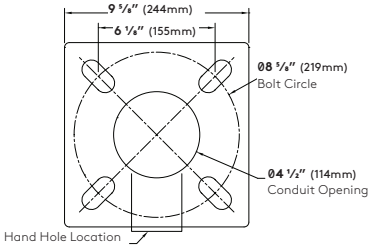


Note: Adequate drainage must be provided in concrete foundation.

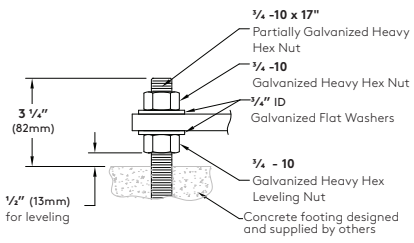
Anchor Bolt Detail for A40



Bolt Circle for AT535
Use caution when setting anchor bolts. Bolts must be vertically straight and centered on dimensions shown



Anchor Bolt Detail for AT535



Selux Corporation © 2019, T 845-834-1400, 800-735-8927, F 845-834-1401, www.selux.us
In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. Specification sheets found at www.selux.us are the most recent versions and supercede all other printed or electronic versions.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page Remove page

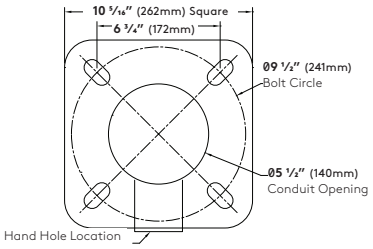
Lanova LED

selux

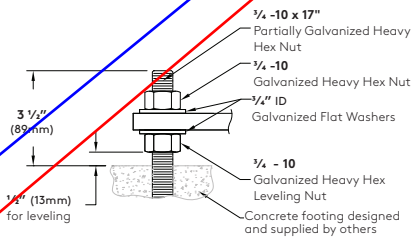
Type:
ALP03
Page 6 of 6

Pole Information
Refer to pole specification sheets for construction details, anchorage information and additional options.

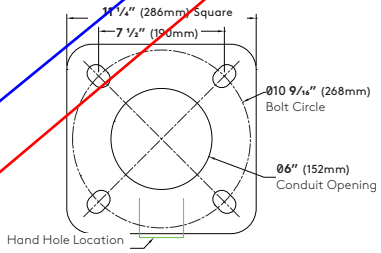
Bolt Circle for AT64
Use caution when setting anchor bolts. Bolts must be vertically straight and centered on dimensions shown



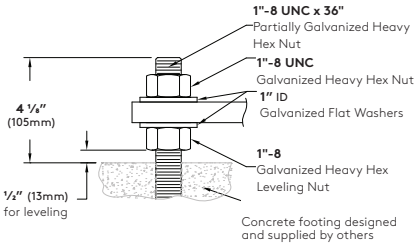
Anchor Bolt Detail for AT64



Bolt Circle for AT74
Use caution when setting anchor bolts. Bolts must be vertically straight and centered on dimensions shown



Anchor Bolt Detail for AT74



Selux Corporation © 2019, T 845-834-1400, 800-735-8927, F 845-834-1401, www.selux.us
In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. Specification sheets found at www.selux.us are the most recent versions and supercede all other printed or electronic versions.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page

Remove page

Manufacturer: Selux : Lenova LED Pole Mount
Description: 12ft Pole Light R1 Type Distribution

Fixture Wattage: 24 W
Lumen Output: 2477 lumen
Lamp CRI: 80+
Lighting Controls: 0-10V Dimming

Voltage: 120 V
Fixture Finish: Dark Grey
Lamp CCT: 2700K
Assembly Code: LAL-R1-X-CL-5G250-XX-30-SP-120-DM-MOD

Date: _____ Customer: _____

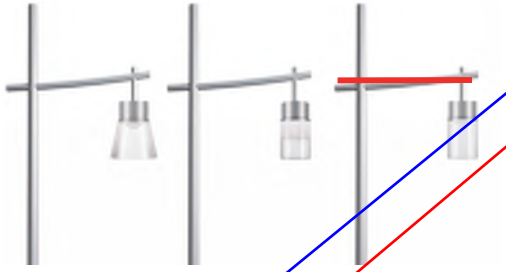
Project: _____

Type: _____ Qty: _____

selux

Type:
ALP04

Lanova LED Pole Mount



straight arm

Order Code: LAL - _____ - _____ - _____ - _____ - _____ - _____ - _____ - _____ - _____ - _____

Pole Order Code: _____ - _____ - _____ - _____

		Series	Height	Finish	Options

LAL	Series	LAL Lanova LED							
_____	Optics	R1 Type I Distribution	R2 Type II Distribution	R3 Type III Distribution	R4 Type IV Distribution	R5S Type V Square	R5R Type V Round	DB Diffuse Bowl	
_____	Mounting	1 Single	2 Double	W Wall					
_____	Cylinder	CL Clear Long	FL[1] ½ Frosted Long	CT Clear Tapered					[1] DB optics only
_____	Light Engine	5G150[2] 1556lm, 15W	5G250[2] 2477lm, 24W	5G350 3468lm, 33W	5G450 4459lm,42W				[2] Not Available with DM, HL30, or HL50 * Based on R2 distribution and 3000K CCT
_____	Power Cord Length	8 8′	10 10′	12 12′	14 14′	16 16′	18 18′	XX[3] XX′	[3] Add length of arm + height of pole to determine power cord length
_____	CCT	30 3000K	40 4000K						for other CCT please consult factory
_____	Finish	WH White	BK Black	BL Semi-Matte Black	BZ Bronze	SV Silver	SP Specify Premium Color		
_____	Voltage	120	208	240	277	347[4,5]	480[4,5]		[4] Not available with HL30 or HL50 [5] Requires stepdown transformer, 60 Hz only
_____	Options	DM Dimming (0-10V)	HL30[6,7] Hi-Lo Switching 30-100%	HL50[6,7] Hi-Lo Switching 50-100%	HS* House Side Shield				[6] 120, 240, and 277V Only [7] Not available with DM option * Not available with RSS, RSR, or DB optics

Product Modifications

Please list modification requirements for review by factory:

Straight arm, power receptacle hidden in base - one circuit per pole

Approvals

Date:

NRTL WET IP65 UNION MADE

Selux Corporation © 2019, T 845-834-1400, 800-735-8927, F 845-834-1401, www.selux.us
In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. Specification sheets found at www.selux.us are the most recent versions and supercede all other printed or electronic versions.

Lighting Notes:

1. Finish to be confirmed by architect.
2. Contractor to coordinate pole mounting with civil scope and other services according to manufacturer recommendations.
3. Modifications include (a) Straight Arms (b) power receptacles hidden in base (c) one circuit per pole.
4. Landscape Architect to Specify Base Cover.
5. Height of pole to be 12’.
6. Refer to drawing to determine single or double mount.
7. Add alternate: Standard Finish

ARUP
Project Number: 271565
Phone: 1 212 896 3000

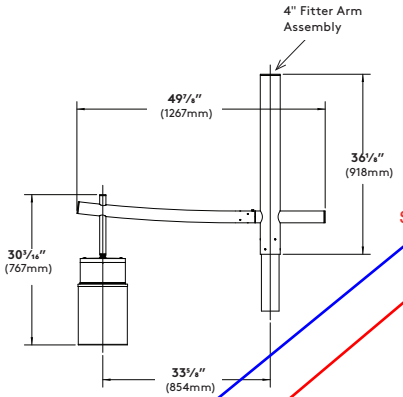
Remove page

Remove page

Lanova LED

selux

Type:
ALP04



Net Weight (19.5 lbs)
EPA = 0.68 ft²

Specifications

Luminaire Housing
Die cast aluminum housing made from low copper marine grade aluminum.

Gasketing
(not shown) Continuous UV resistant silicone gasket provides weatherproofing, dust and insect control at all fixture connections.

LED Array
(not shown) High Flux LEDs mounted to metal core PCB and attached to aluminum heat sink for maximum LED performance and life. CCT tolerance within a 3 step bin and provided with a minimum CRI of 80. LED light engine has a reported lumen maintenance of 93% at 50,000 hours. L70 calculated greater than 100,000 hours.

LED Optics
Clear half frosted, or tapered UV stabilized acrylic outer cylinder creates the optical chamber. Technical Optics (R1, R2, R3, R4, R5S and R5R) use Selux signature light pattern acrylic lens holder to secure proprietary silicone optics. Diffuser Bowl (DB) option made of highly diffuse UV stabilized acrylic hides LED source and provides a pleasant/soft light quality.

LED Driver
LEDs are driven by RoHS compliant constant current programmable LED driver. Driver includes 0-10V dimming to 10%, meets the requirements of IP65 and includes a 5 Year warranty.

Surge Protector
(not shown) Independent surge protector device designed to protect luminaire from electrical surge up to 20kA.

Power Cord
(not shown) UV resistant black SJ power cord pre-installed at factory. Please specify power cord length available in 1' increments from 5' – 30'.

Standard exterior colors are White (WH), Black (BK), Semi-Matte Black (BL), Bronze (BZ), and Silver (SV). Selux premium colors (SP) are available, please specify from your Selux color selection guide.

5 Year Limited LED Luminaire Warranty - Selux offers a 5 Year Limited Warranty to the original purchaser that the Lanova LED luminaire shall be free from defects in material and workmanship for up to five (5) years from date of shipment. This limited warranty covers the LED driver and LED array when installed and operated according to Selux instructions. For details, see "Selux Terms and Condition of Sale."

Listings and Ratings: Luminaire tested to IP65 and LM-79 standards. LEDs tested to LM-80 standards.

Luminaire suitable for ambient temperatures from 40°C (104°F) maximum to -40°C (-40°F) minimum.

NRTL Listed (i.e. UL, CSA)

Visit selux.us for our LED End of Life recycling policy.

Selux Corporation © 2019, T 845-834-1400, 800-735-8927, F 845-834-1401, www.selux.us
In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. Specification sheets found at www.selux.us are the most recent versions and supercede all other printed or electronic versions.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page

Remove page

Lanova LED

selux

Type:

ALP04

Mounting

1 - Single Arm

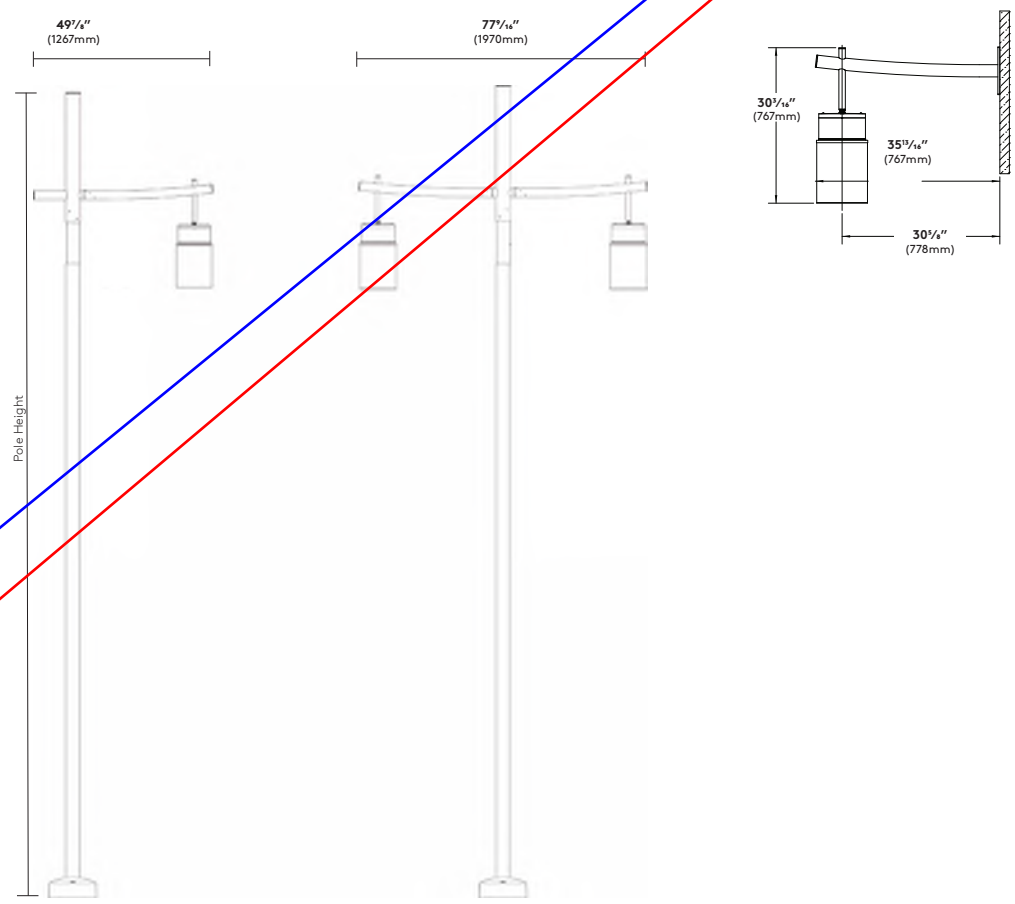
EPA = 1.57ft²
Weight = 32lbs. (15kg)

2 - Double Arm

EPA = 1.3ft²
Weight = 55lbs. (25kg)

W - Wall Mount Arm

EPA = N/A
Weight = 24lbs. (11kg)



Selux Corporation © 2019, T 845-834-1400, 800-735-8927, F 845-834-1401, www.selux.us
In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. Specification sheets found at www.selux.us are the most recent versions and supercede all other printed or electronic versions.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page Remove page

Lanova LED

selux

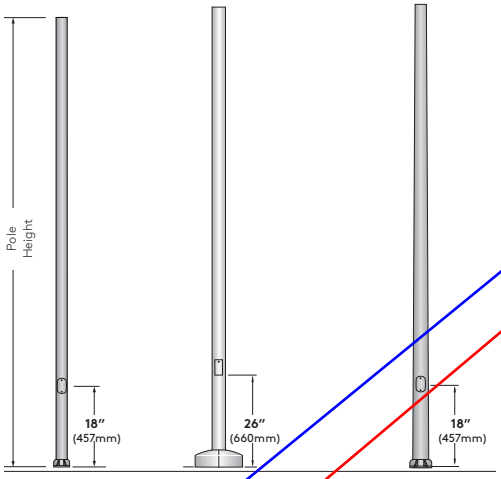
Type:
ALP04

Pole Information
Refer to pole specification sheets for construction details, anchorage information and additional options.

A35/S35 Round Straight Aluminum Pole

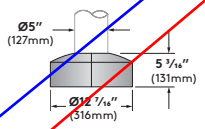
A40 Round Straight Aluminum Pole

AT535/AT64/AT74 Tapered Aluminum Pole

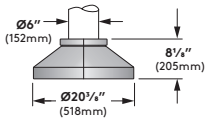


Optional Base Covers for Poles
Die cast aluminum.

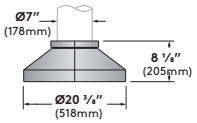
BC3 Optional Base Cover (AT535)
Die cast aluminum, two-piece field installable base cover.



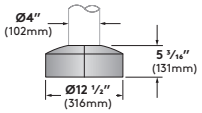
BC9 Optional Base Cover (AT64)
Die cast aluminum, two-piece field installable base cover.



BC10 Optional Base Cover (AT74)
Die cast aluminum, two-piece field installable base cover.



BC13 Optional Base Cover (A40)
Die cast aluminum, two-piece field installable base cover.



Pole Data Chart

Pole Series	Bolt Circle	90 mph	100 mph	110 mph	120 mph	130 mph	140 mph	150 mph	160 mph	170 mph	180 mph	Height
A35 3½" Round Straight Aluminum Pole	7¾"	4.8	3.5	2.6	1.8	1.3	0.9	0.7	0.6	-	-	**12** 12ft
A40 4" Round Straight Aluminum Pole	7½"	9.3	7.2	5.6	4.5	3.7	3.1	2.7	2.3	2.0	1.7	
AT535 5" to 3½" Round Tapered Aluminum Pole	8⅛"	13.4	10.5	8.4	6.9	5.8	4.9	4.2	3.6	3.2	2.8	
AT64 6" to 4" Round Tapered Aluminum Pole	9½"	20.3	16.1	13.1	10.9	9.2	7.9	6.8	5.9	5.2	4.5	
A35 3½" Round Straight Aluminum Pole	7¾"	3.5	2.4	1.6	1.0	0.5	-	-	-	-	-	**14** 14ft
A40 4" Round sraight Aluminum Pole	7½"	10.3	7.9	6.1	4.9	4.0	3.4	2.9	2.5	2.1	1.8	
AT535 5" to 3½" Round Tapered Aluminum Pole	8⅛"	11.2	8.7	6.9	5.5	4.6	3.8	3.3	2.8	2.4	2.1	
AT64 6" to 4" Round tapered Aluminum Pole	9½"	17.2	13.6	11.0	9.1	7.6	6.5	5.6	4.8	4.2	3.7	
A35 3½" Round Straight Aluminum Pole	7¾"	2.1	1.2	0.6	-	-	-	-	-	-	-	**16** 16ft
A40 4" Round sraight Aluminum Pole	7½"	8.3	6.2	4.7	3.6	3.0	2.5	2.1	1.7	1.5	1.2	
AT535 5" to 3½" Round tapered Aluminum Pole	8⅛"	9.1	6.9	5.4	4.3	3.4	2.9	2.4	2.0	1.7	1.5	
AT64 6" to 4" Round tapered Aluminum Pole	9½"	14.3	11.2	9.0	7.4	6.2	5.2	4.4	3.8	3.3	2.9	
A40 4" Round sraight Aluminum Pole	7½"	6.6	4.8	3.5	2.6	2.1	1.7	1.4	1.1	0.9	0.7	**18** 18ft
AT535 5" to 3½" Round tapered Aluminum Pole	8⅛"	9.2	7.0	5.4	4.2	3.4	2.8	2.3	2.0	1.7	1.4	
AT64 6" to 4" Round tapered Aluminum Pole	9½"	11.9	9.2	7.3	6.0	4.9	4.2	3.5	3.0	2.6	2.2	
AT74 7" to 4" Round tapered Aluminum Pole	10⅝"	17.5	13.8	11.2	9.2	7.7	6.5	5.6	4.8	4.1	3.5	

Allowable EPA calculated according to AASHTO 1994 and include allowance for 1/3 gust factor. See Mounting Configuration pages for fixture arm weight and EPA values.

Finish

WH White
BK Black
BL Semi-Matte Black
BZ Bronze
SV Silver
SP Specify Premium Color

Options

BC3 Decorative Cast Aluminium Base Cover (AT535)
BC9 Decorative Cast Aluminium Base Cover (AT64)
BC10 Decorative Cast Aluminium Base Cover (AT74)
BC13 Decorative Cast Aluminium Base Cover (A40)
T35 Supplied with 3½" diameter tenon, 4½" high (use for A40, AT64, AT74 only)
REC1 GFCI Receptacle with weather-proof cover
REC2 GFCI Receptacle with weather-proof padlockable in-use cover
REC3 USB and Duplex Receptacle with weather-proof cover
REC4 USB and Duplex Receptacle with weather-proof padlockable in-use cover
Motion Sensor w/ Optional Photocell

Selux Corporation © 2019, T 845-834-1400, 800-735-8927, F 845-834-1401, www.selux.us
In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. Specification sheets found at www.selux.us are the most recent versions and supercede all other printed or electronic versions.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page Remove page

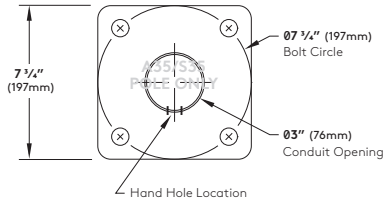
Lanova LED

selux

Type:
ALP04

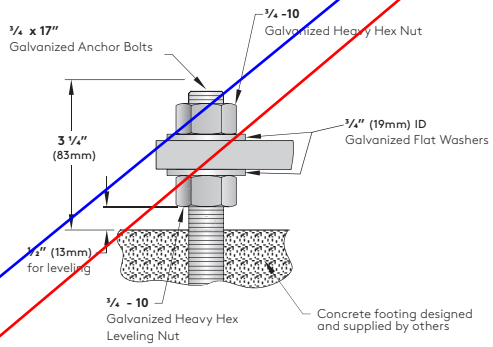
Pole Information
Refer to pole specification sheets for construction details, anchorage information and additional options.

Bolt Circle for A35 & S35
Use caution when setting anchor bolts. Bolts must be vertically straight and centered on dimensions shown

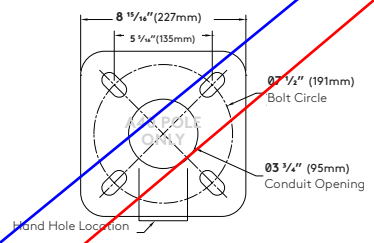


Note: Adequate drainage must be provided in concrete foundation.

Anchor Bolt Detail for A35 & S35

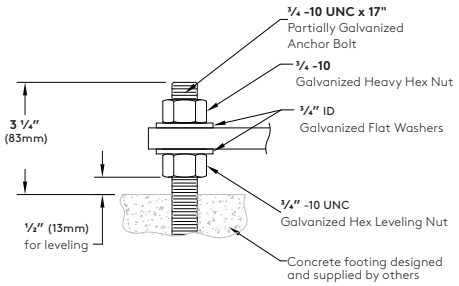


Bolt Circle for A40
Use caution when setting anchor bolts. Bolts must be vertically straight and centered on dimensions shown

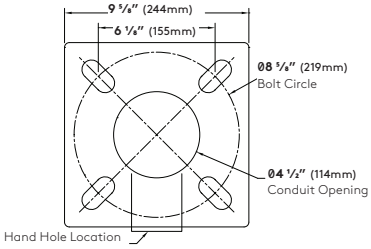


Note: Adequate drainage must be provided in concrete foundation.

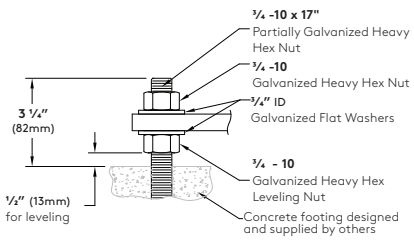
Anchor Bolt Detail for A40



Bolt Circle for AT535
Use caution when setting anchor bolts. Bolts must be vertically straight and centered on dimensions shown



Anchor Bolt Detail for AT535



Selux Corporation © 2019, T 845-834-1400, 800-735-8927, F 845-834-1401, www.selux.us
In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. Specification sheets found at www.selux.us are the most recent versions and supercede all other printed or electronic versions.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page Remove page

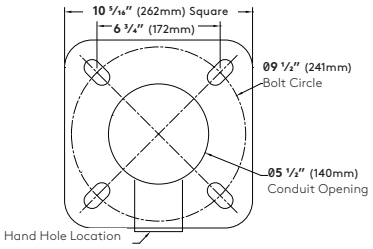
Lanova LED

selux

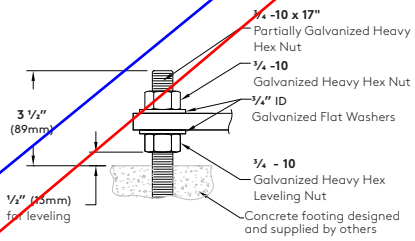
Type:
ALP04

Pole Information
Refer to pole specification sheets for construction details, anchorage information and additional options.

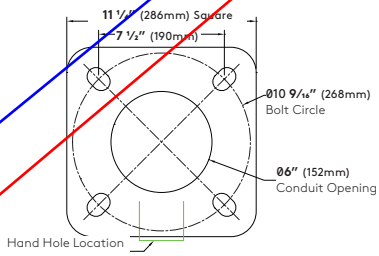
Bolt Circle for AT64
Use caution when setting anchor bolts. Bolts must be vertically straight and centered on dimensions shown



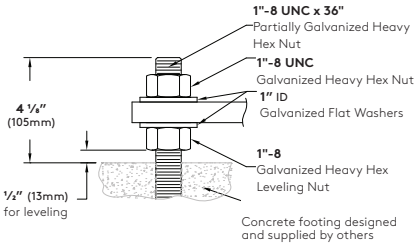
Anchor Bolt Detail for AT64



Bolt Circle for AT74
Use caution when setting anchor bolts. Bolts must be vertically straight and centered on dimensions shown



Anchor Bolt Detail for AT74



Selux Corporation © 2019, T 845-834-1400, 800-735-8927, F 845-834-1401, www.selux.us
In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. Specification sheets found at www.selux.us are the most recent versions and supercede all other printed or electronic versions.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page Remove page

Lanova LED

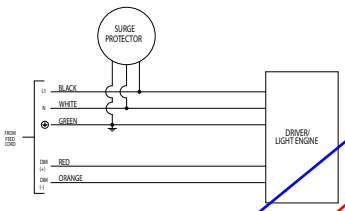
selux

Type:
ALP04

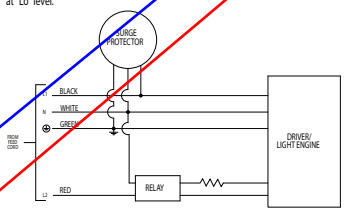
ELECTRICAL SPECIFICATIONS									
CCT	3000K/4000K								
CYLINDER	CL Cylinder Standard						FL Cylinder Standard		
OPTICS	R1, R2, R3, and R4			R5R and R5S			DB		
Light Engine/ Electrical Specs	Delivered Lumens (lm)	Wattage (W) 120-277 / 347-480	Efficacy (lm/W)	Delivered Lumens (lm)	Wattage (W) 120-277 / 347-480	Efficacy (lm/W)	Delivered Lumens (lm)	Wattage (W) 120-277 / 347-480	Efficacy (lm/W)
5G150	1316	14.2 / 18	92.9	1488	14.2 / 18	105.0	1327	14.2 / 18	93.5
5G250	2193	23.6 / 27	92.9	2480	23.6 / 27	105.0	2211	23.6 / 27	93.5
5G350	3070	33.1 / 35	92.9	3471	33.1 / 35	105.0	3096	33.1 / 35	93.5
5G450	3948	42.5 / 44	92.9	4463	42.5 / 44	105.0	3981	42.5 / 44	93.5

Wiring

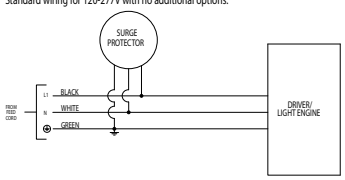
0-10V Dimming Option (DM) Wiring for 120-277V
100% light output at 10V, down to 1% light output at 0V.



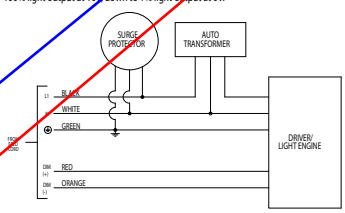
Hi-Lo Switching Option (HL30/HL50) Wiring
120/240/277V. When red is energized, light output will be at "Lo" level.



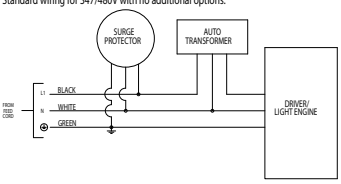
Standard Wiring for 120-277V
Standard wiring for 120-277V with no additional options.



0-10V Dimming Option (DM) Wiring for 347/480V
100% light output at 10V, down to 1% light output at 0V.



Standard Wiring for 347/480V
Standard wiring for 347/480V with no additional options.



Selux Corporation © 2019, T 845-834-1400, 800-735-8927, F 845-834-1401, www.selux.us
In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. Specification sheets found at www.selux.us are the most recent versions and supercede all other printed or electronic versions.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page Remove page

Lanova LED

selux

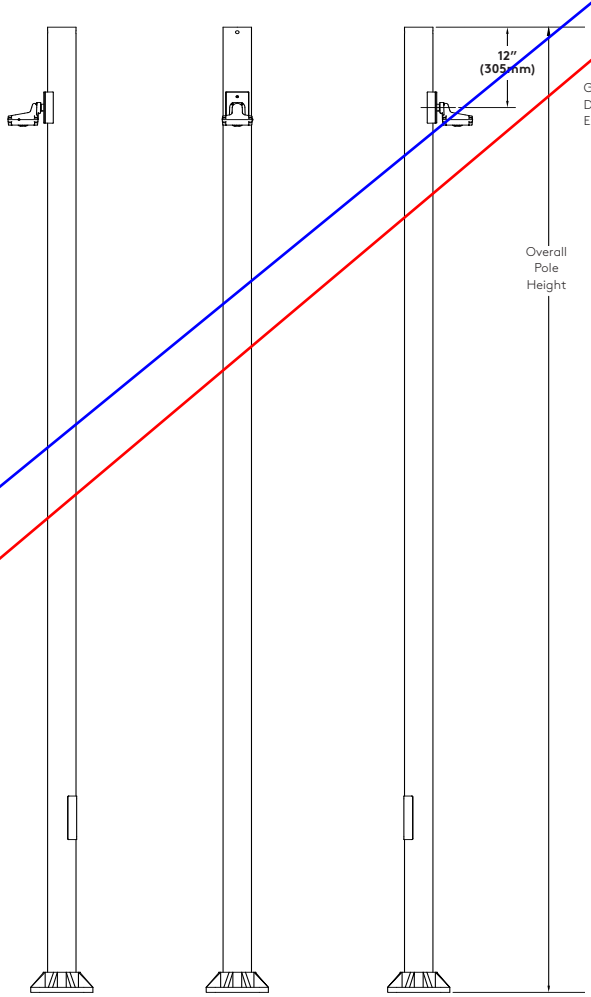
Type:
ALP04

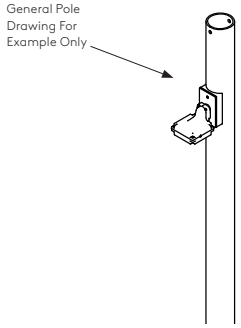
Pole Motion Sensor

The Selux outdoor rated sensor incorporates Passive Infrared (PIR) technology for motion sensing and also includes a built in photocell. Designed to mount directly through a 1/2" KO in a single gang faceplate on pole/column, the SBO utilizes 100% Digital Passive Infrared (PIR) technology that is tuned for walking size while preventing false tripping from the environment.

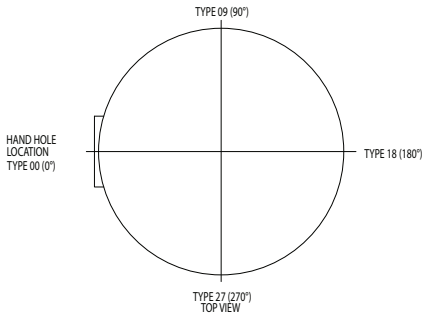
Series	Optics	Hand Hole Orientation	Program	Color	Photocell Feature	Voltage
MS Motion Sensor	**1** 270° coverage - Single Sensor	**00**	**D0** (0V=0%)	**WH** White	**Y** Yes	**UNV**
		09	**D1** (1V=10%)	**BK** Black	**N** No	**347**
		18	**D3** (3V=30%)	**BZ** Bronze		**480**
		27	**D5** (5V=50%)			

NOTE: Motion sensor comes programmed at 30% dimmed level with a 5 min. delay as default. All programming required after shipping by others.





Sensor angular orientation from hand hole 0°
90° increments clockwise around pole (Type 00,09,18,27)



Selux Corporation © 2019, T 845-834-1400, 800-735-8927, F 845-834-1401, www.selux.us
In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. Specification sheets found at www.selux.us are the most recent versions and supercede all other printed or electronic versions.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:

Pond Pavilion

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Manufacturer: LED LINEAR : HYDRA HD IP67
Description: Under bench linear LED wet rated

Fixture Wattage: 80 W/ft
Lumen Output: 151 lumen/ft
Lamp CRI: 80+
Lighting Controls: 0-10V Dimming

Voltage: 120 V
Fixture Finish: Standard
Lamp CCT: 2200K (Fixture 2700K)
Assembly Code: HD6-W8-22-XX-S-A-BS-IP67

Type:
AL14

XOOLUM IP67 Static White

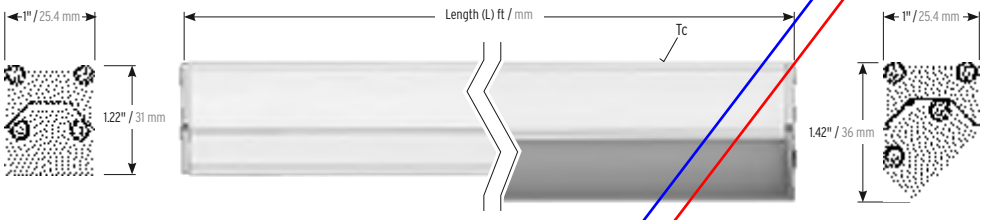
24 V, modular, light intensive linear LED luminaire in IP67 with adjustable luminaire head (45°) and 3 clear encapsulated reflector optics. Available in silver or black profile color as surface-mounted version. 2.56' black cable with open end on one side. High quality and homogeneous illumination. Japanese LED. CRI up to 95. Binning 3 MacAdam. Lifetime of > 60,000 hrs (L80/B10). Installation friendly, attachable and durable luminaire housing with a small cross section made from extruded and anodized aluminum with screwed Al-end caps. Engineered in Germany.

Project name

Fixture type | Phase

Specifier | Date

Dimensions & available lengths



Extruded and anodized aluminum housing

Tc-point (Case temp.) on the rear side of the module

Lighting head, 45° adjusted

Fixture build to length (not field cutable):

L_{min}: 7.8"; L_{max}: 13.16' (HD25: 9.88'); in 2.46" increments
L_{min}: 198 mm; L_{max}: 4,010 mm (HD25: 3,010 mm); in 62.5 mm increments

Electrical & output data

Voltage	24 Volt (23 V_{min}, 25 V_{max})
Temperature[2]	Tc_{min} = -13°F / -25°C, Tc_{max} (Table below)
Storage temperature	Ts_{min} = -22°F / -30°C, Ts_{max} = 185°F / 85°C
Ambient temperature	Ta_{min} = -13°F / -25°C, Ta_{max} (Table below)
CRI	up to 95
R9	up to 65

XOOLUM™ HYDRA	HD6	HD10	HD15	HD25
Power (W/ft / W/m)[1]	1.8 / 6	3.1 / 10	4.6 / 15	7.6 / 25
Efficacy (lm / W)[1] @ W850	52	51	55	53
max. length (ft / m)	13.1 / 4	13.1 / 4	13.1 / 4	9.8 / 3
Temperature Tc-point (Tc_{max})[2]	140°F / 60°C	140°F / 60°C	140°F / 60°C	149°F / 65°C
Ambient temperature (Tc_{max})	104°F / 40°C	104°F / 40°C	104°F / 40°C	95°F / 35°C

Color temperature LED tape used[3]		Color temperature delivered finished fixture		HD6 low output	HD10	HD15	HD25 high output
				lumen/feet (lm/ft)[1] lumen/meter (lm/m)[1]			
W820	2000 K	2400 K		54 / 180	90 / 300	145 / 480	234 / 770
W822	2200 K	2700 K		60 / 200	103 / 340	164 / 540	267 / 880
W825	2500 K	3000 K		69 / 230	118 / 390	188 / 620	307 / 1010
W827	W927 2700 K	3500 K	3400 K	63 / 210	106 / 350	200 / 660	325 / 1070
W830	W930 3000 K	3900 K	3800 K	63 / 210	106 / 350	212 / 700	346 / 1140
W835	W935 3500 K	4600 K	4400 K	66 / 220	109 / 360	222 / 730	362 / 1190
W840	W940 4000 K	5500 K	5600 K	66 / 220	112 / 370	228 / 750	371 / 1220
W850	5000 K	7200 K		93 / 310	154 / 510	249 / 820	404 / 1330

ONE BIN ONLY
Lifetime L80/B10 > 60.000 h
LM 79 compliant
LM 80 compliant
UV protected
Resistant to solvents
Saltwater resistant
Temporary immersion protection
Impact resistant IK10

[1] The given data are typical values. Due to tolerances of the production process and the electrical components, values for light output and electrical power can vary up to 10%.

[2] The Tc-point should be measured in thermal equilibrium according to IEC EN 60598-1.

[3] In case of IP67 products, tolerances in the color temperature can occur. For further explantation, please see specification catalogue 2016/2017.

LED Linear™ GmbH

Safety and assembly information please see specification catalogue 2018/2019.

Lighting Notes:

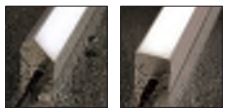
1. Refer to Architects Drawings for Fixture Length and Mounting Details
2. Coordinate Remote driver location with architect in nearest possible weather-proofed location. All wiring, cables and leads shall be fully concealed from view.
3. Provide with 2200K source LED to ensure the fixture delivers 2700K.

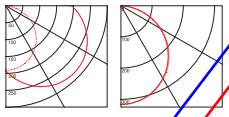
ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:
AL14

Order code

Your order code	XOOLUM HYD	HD__	W_	__	_____	_	___	___	IP67
Order code example	XOOLUM HYD	HD25	W8	27	2010	S	A	BS	IP67





opal encapsulation
DIN 5040:A50

LED tape
HYDRA HD6 ..... HD6
HYDRA HD10 ..... HD10
HYDRA HD15 ..... HD15
HYDRA HD25 ..... HD25

Color rendering
> 80 8
> 90 (only HD6, HD10) 9

Color temperature delivered finished fixture	Color temperature LED tape used	
2400 K	2000 K	20
2700 K	2200 K	22
3000 K	2500 K	25
3500 K 3400 K	2700 K	27
3900 K 3800 K	3000 K	30
4600 K 4400 K	3500 K	35
5500 K 5600 K	4000 K	40
7200 K	5000 K	50

Length
L_{min}: 7.8" (198 mm);
L_{max}: 13.16' (4,010 mm); HD25: 9.88' (3,010 mm);
in 2.46" (62.5 mm) increments

Profile color
Silver ..... S
Black ..... B

Options
Non adjustable ..... NA
Adjustable ..... A

Cable feed[4]
Back side, 6.56' / 2 m
(through mounting channel) ..... BS
Front side, 6.56' / 2 m
(through end caps) ..... FS

Ingress protection
IP67 ..... IP67

[4] Cable feed

Please choose your accessories

☑ Fixture comes with 6.56' / 2 m open end cable.

Mounting

☑ no further accessories required, fixture base profile = mounting channel

! Note: Number of mounting accessories depending on the profile length.

Length of profiles (ft / mm)	Number of mounting accessories
0.25 - 4 / 0 - 1,000	2
4 - 7 / 1,001 - 2,000	3
7 - 10 / 2,001 - 3,000	4
10 - 13 / 3,001 - 4,000	5

Mounting (optional)	Art.-#	
☐ XOOLUM™ 007 Swivel-Angle Set +/- 45°	13000081	
☐ VarioPendant 007 Slide Silver	13000157	
☐ VarioPendant 007 Slide black	13000158	

Recommended driver

☐ MEAN WELL HLG-100H-24A

Recommended control

☐ EldoLED LINEARdrive DC 180D

For max. cable length between driver and fixture please visit **www.led-linear.com/cable-length**

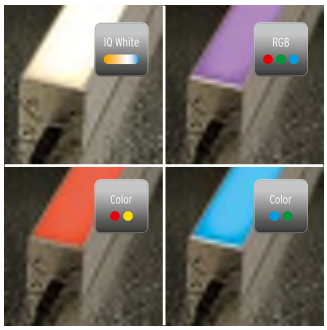
Safety and assembly information please see specification catalogue 2018/2019.

LED Linear™ GmbH

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:
AL14

XOOLUM IP67 Tunable White/Color/RGB



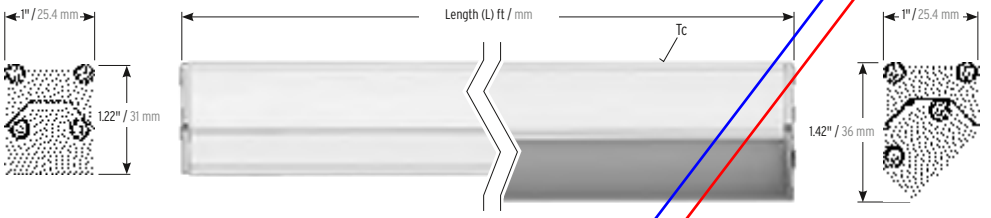
24 V, modular, light intensive linear LED luminaire in IP67 with adjustable luminaire head (45°) and a homogeneous light emission surface due to an opal encapsulation. Available in silver or black profile color as surface-mounted version. 2.56' black cable with open end on one side. High quality and homogeneous illumination. Japanese LED. CRI up to 85. Lifetime of > 60,000 hrs (L80/B10 at Tunable White) resp. 30,000 hrs (L80 at RGB and Color). Installation friendly, attachable and durable luminaire housing with a small cross section made from extruded and anodized aluminum with screwed Al-end caps. Engineered in Germany.

Project name

Fixture type | Phase

Specifier | Date

Dimensions & available lengths



Extruded and anodized aluminum housing

Tc-point (Case temp. on the rear side of the module

Lighting head, 45° adjusted

Fixture build to length (not field cutable):

L_{min}: 7.8" (ATON Color: 5.31"); L_{max}: 13.16'; in 2.46" increments (ATON Color:4.92")
L_{min}: 198 mm (ATON Color: 135 mm); L_{max}: 4,010 mm; in 62.5 mm increments (ATON Color: 125 mm)

Electrical & output data

Voltage	24 Volt (23 V_{min}, 25 V_{max})
Temperature[2]	Tc_{min} = -13°F / -25°C, Tc_{max} = 158°F / 70°C
Storage temperature	Ts_{min} = -22°F / -30°C, Ts_{max} = 185°F / 85°C
Ambient temperature	Ta_{min} = -13°F / -25°C, Ta_{max} = 104°F / 40°C

	IQ White ATON		RGB	ATON Color		ECO HD8	
XOOLUM™	HD12	HD24	HD20	Red	Yellow	Blue	Green
Power (W/ft / W/m)[1]	3.7 / 12	7.3 / 24	6.7/ 22	2.4 / 8	2.4 / 8	2.4 / 8	2.4 / 8
Efficacy (lm / W)[1]	86	89	19	8	15	10	39
max. length (ft / m)	13.1 / 4	13.1 / 4	13.1 / 4	13.1 / 4	13.1 / 4	13.1 / 4	13.1 / 4
CRI	85	85	-	-		-	
R9	20	20	-	-		-	

LED tape	Color temperature[3]	Color (λ_d)	lumen/feet (lm/ft)[2] lumen/meter (lm/m)[2] @ clear cover[1]
IQ White ATON HD12	W822 (2300 K) - W840 (4900 K)	-	116[4] / 380[4]
IQ White ATON HD24		-	241[4] / 790[4]
RGB HD20	-	622 (R)/532 (G)/466 (B)	115[4] / 376[4]
ATON Color Red	-	625 nm	20 / 64
ATON Color Yellow	-	595 nm	12 / 39
ECO HD8 Blue	-	468 nm	24 / 78
ECO HD8 Green	-	526 nm	94 / 309

[1] The given data are typical values. Due to tolerances of the production process and the electrical components, values for light output and electrical power can vary up to 10%.

[2] The Tc-point should be measured in thermal equilibrium according to IEC EN 60598-1.

[3] In case of IP67 products, tolerances in the color temperature can occur. For further explantation, please see specification catalogue 2016/2017.

[4] When all single colors are at full power.

IQ White ONE BIN ONLY

IQ White Lifetime — L80/B10 > 60.000 h

Color/RGB Lifetime — L80 30.000 h

LM 79 compliant

LM 80 compliant

UV protected

Resistant to solvents

Saltwater resistant

Temporary immersion protection

Impact resistant — IK10

LED Linear™ GmbH

Safety and assembly information please see specification catalogue 2018/2019.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:
AL14

Order code

Your order code	XOOLUM	_____	____	_	__	__	IP67
Order code example	XOOLUM	ATON Color R	1010	S	A	BS	IP67

LED tape
IQ White ATON HD12 ..... IQ W ATON HD12
IQ White ATON HD24 ..... IQ W ATON HD24
RGB HD20 ..... RGB HD20
ATON Color Red ..... ATON Color R
ATON Color Yellow ..... ATON Color Y
ECO HD8 Blue ..... ECO HD8 B
ECO HD8 Green ..... ECO HD8 G

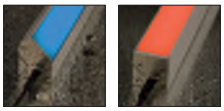
Length
L_{min}: 7.8" (198 mm); ATON Color: 5.31" (135 mm);
L_{max}: 13.16' (4,010 mm);
in 2.46" (62.5 mm) increments; ATON Color: 4.92" (125 mm)

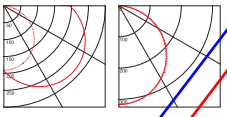
Profile color
Silver ..... S
Black ..... B

Options
Non adjustable ..... NA
Adjustable ..... A

Cable feed[5]
Back side, 6.56' / 2 m
(through mounting channel) ..... BS
Front side, 6.56' / 2 m
(through end caps) ..... FS

Ingress protection
IP67 ..... IP67





opal encapsulation
DIN 5040:A50

[5] Cable feed

Please choose your accessories

☑ Fixture comes with 6.56' / 2 m open end cable.

Mounting

☑ no further accessories required, fixture base profile = mounting channel

! Note: Number of mounting accessories depending on the profile length.

Length of profiles (ft / mm)	Number of mounting accessories
0.25 - 4 / 0 - 1,000	2
4 - 7 / 1,001 - 2,000	3
7 - 10 / 2,001 - 3,000	4
10 - 13 / 3,001 - 4,000	5

Mounting (optional)	Art.-#
☐ XOOLUM™ 007 Swiver-Angle Set +/- 45°	13000081
☐ VarioPendant 007 Slide Silver	13000157
☐ VarioPendant 007 Slide black	13000158

Recommended driver

☐ MEAN WELL HLG-100H-24A

Recommended control

☐ EldoLED LINEARdrive DC 180D

For max. cable length between driver and fixture please visit **www.led-linear.com/cable-length**

Safety and assembly information please see specification catalogue 2018/2019.

LED Linear™ GmbH

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page

Remove page

Type:
AL14

XOOLUM IP67

LED LINEAR™ lighting solutions | Member of the Fagerhult Group

Drivers

Item		Specifications	Downloads
LED LINEAR™ Non-Dimmable Drivers		• UL 8750 Listed Enclosure - With Built-In Junction Boxes • Universal Input Voltage 120V - 277V • IP65 - For Both Indoor and Outdoor Use • No Minimum Load Requirement • 24V Constant Voltage Output, Class 2 • Available in three wattages 30W, 60W and 96W • Max. Dimensions: 12-1/8" x 2-3/8" x 1-3/8"	30 W SPEC SHEET 60 W SPEC SHEET 96 W SPEC SHEET INSTALLATION INSTRUCTIONS
LED LINEAR™ 0-10V Dimmable Drivers		• UL 8750 Listed Enclosure - With Built-In Junction Boxes • 0-10V Dimmable - Flicker Free Down to 1% • Universal Input Voltage 120V - 277V • IP65 - For Both Indoor and Outdoor Use • 24V Constant Voltage Output, Class 2, Class P • Available in three wattages 30W, 60W and 96W • Max. Dimensions: 12-1/8" x 2-3/8" x 1-3/8"	30 W SPEC SHEET 60 W SPEC SHEET 96 W SPEC SHEET INSTALLATION INSTRUCTIONS
LED LINEAR™ ELV/Triac Dimmable Drivers		• UL 8750 Listed Class 2 Enclosure • 24V constant voltage output • Compact size yet high efficiency and performance in dry and damp environments (IP67) • Multiple Inputs: 120V or 277V • Fully dimmable: ELV Dimmers - Reverse or Adaptive Phase Control, Trailing Edge • Available in two wattages 48W and 96W • Multiple Circuits are available up to 4 units (up to 384W)	48 W SPEC SHEET 96 W SPEC SHEET INSTALLATION INSTRUCTIONS
MW PWM Dimmable Drivers		• Universal AC input / Full range (up to 305VAC) • Constant voltage PWM style output • Built-in 3 in 1 dimming function (0~10Vdc or PWM signal or resistance) • Dimming range : 0~100% • Class 2 power unit • Suitable for dry / damp / wet locations • UL Recognized component, 5 years warranty	40 W SPEC SHEET 60 W SPEC SHEET 90 W SPEC SHEET INSTALLATION INSTRUCTIONS
LUTRON Dimmable Drivers		• UL Listed Enclosure • Dimming Range: 100% to 1% and 0.1% (Premiere) • LED lighting turns on to any dimmed level without flashing to full brightness • Operating Voltage: 120V~ to 277V~ at 50/60 Hz • Rated lifetime of 50,000 hours at 40°C (104°F) ambient temperature and maximum loading • For rated warranty, ambient temperature not to exceed 40°C (104°F) • Open-circuit protected output	HI-LUME SPEC SHEET HI-LUME PREMIERE SPEC SHEET INSTALLATION INSTRUCTIONS
eldoLED DALI/DMX Dimmable Drivers		• Available in linear or rectangular format • 100W, DMX/DALI interface • 4 control channels • 24V constant voltage, 4 x 24V outputs • Metal or plastic case options	100 W SPEC SHEET INSTALLATION INSTRUCTIONS

Controllers

Item		Specifications	Downloads
eldoLED Controllers	 	**180/D** DMX Controller for RGB and Tunable White Applications **210/D** Dali Contoller for Static White, RGB and Tunable White Aplications **211/D-LG** 0-10V Logarithmic Dimming Controller **211/D-LN** 0-10V Linear Dimming Controller **212/D** DMX Controller for Static White and Static Color Applications **DimWheel** DMX Wall Controller for RGB and Tunable White Applications	180/D SPEC SHEET 210/D SPEC SHEET 211/D-LG SPEC SHEET 211/D-LN SPEC SHEET 212/D SPEC SHEET DIM WHEEL SPEC SHEET

Click for more information

PRODUCT BROCHURE | INSTALLATION | IES FILES | DRIVERS & CONTROLS

LED Linear™ USA, Inc. | Edition: 28/01/2019

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page

Remove page

Manufacturer: Sonneman + SORAA
Description: Lampshade + Lamp

Fixture Wattage: 11 W
Lumen Output: 725 lumen
Lamp CRI: 90+
Lighting Controls: 0-10V Dimming

Voltage: 120 V
Fixture Finish: To be specified by architects
Lamp CCT: 3000K
Assembly Code: See Lighting Notes

Section through Pond Pavilion showing various height settings of pendants

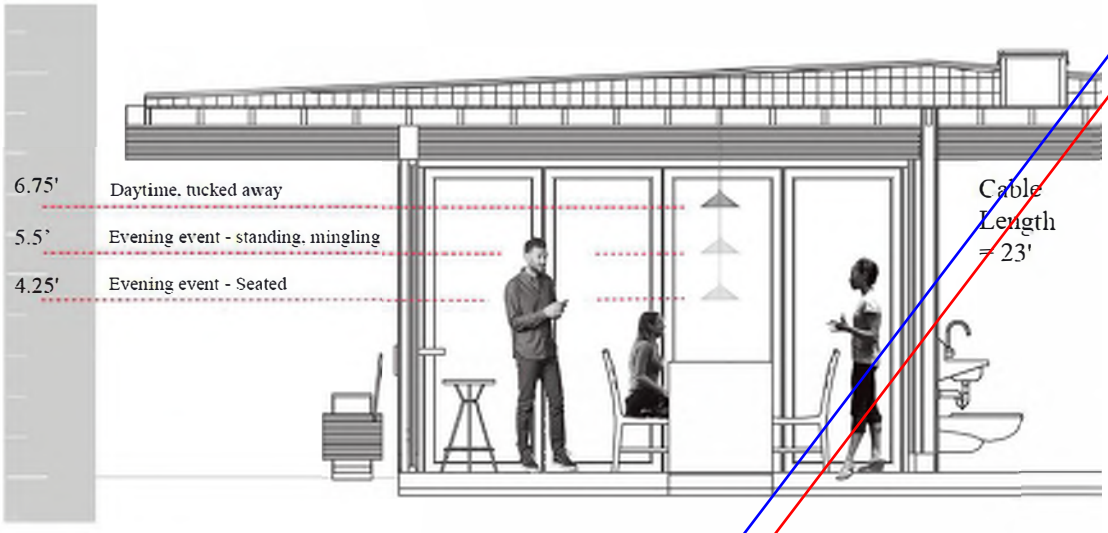
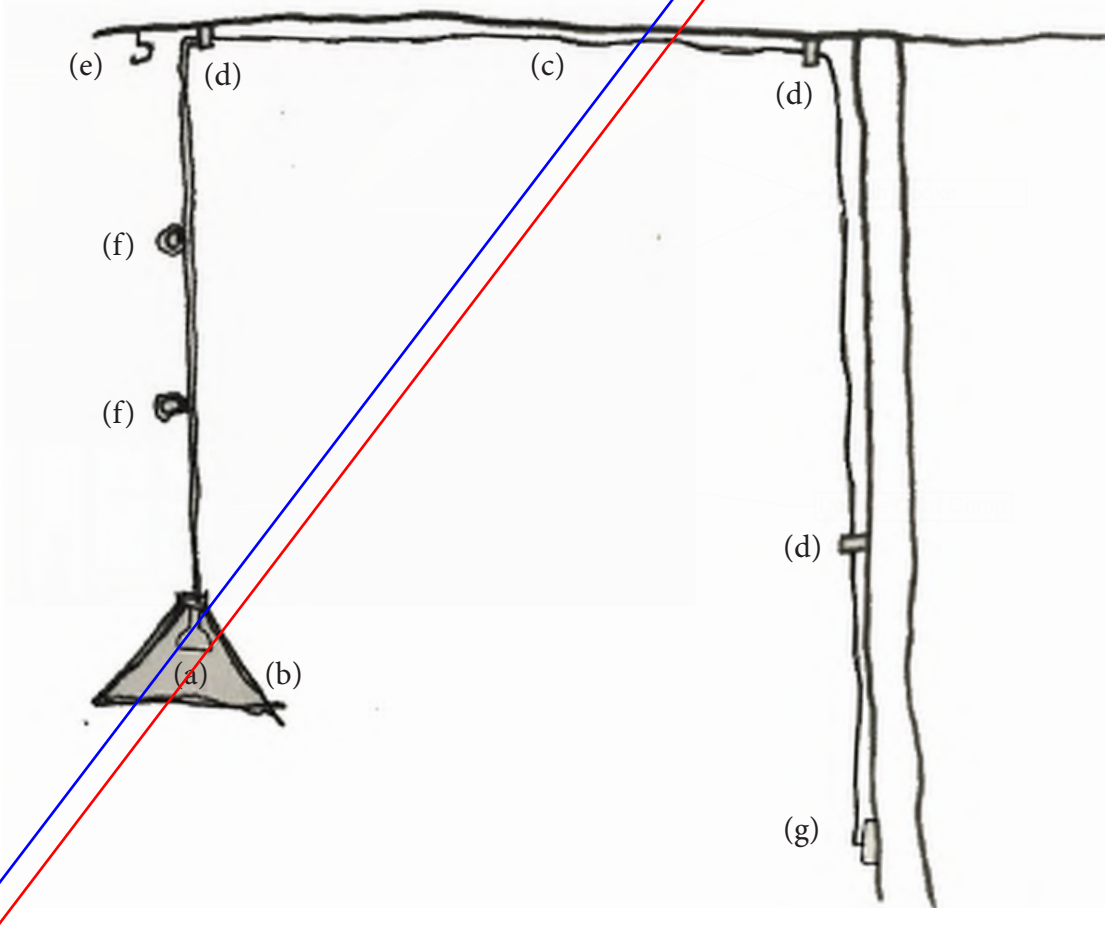


Diagram indicating pendant kit of parts



Type:

AP01

Lighting Notes:

1. All finishes to be specified by architect.
2. This product consists of: (a) 1x Lamp (b) 1x Lamp Shade (c) 1x 23' Cord (d) 3x Pinch Hooks (e) 1x Round Hooks (f) 2x Double Cord Crimps (g) Mounting
3. Lamp to be SORAA Vivid BR30 SB30-11-120D-930-01-04218
4. Pinch Hook to be Color Cord PHK-100-998.
5. Round Hook to be Color Cord PHK-110-998.
6. Double Cord Crimp to be ElecDirect.com Copper Alloy Split Bolt Connector S/2/0
7. Lamps shade to be Sonneman Koma Meiji.
8. Sonneman to provide extra long cord and mounting canopy.
9. Refer to Architectural drawings for preset mounting height. Contractor to coordinate with architect and lighting consultant for final mounting height at aiming and focus session for adjustable mounting height fixtures.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

COLOR CORD COMPANY

Contact: 1-800-409-1070 or info@colorcord.com

Round Swag Hook / Raw Metal

Price: $12.00 - Item Number: PHK-110-998

Overview

The Round Swag Hook from Color Cord Company offers you a tried and true method for altering the shape of your hanging light fixtures and plug-in pendants with a little extra sag and swag. This round hook is an exclusive design created by the Color Cord team that isn't available anywhere else. Since most of our fixtures don't come with a hook for hanging the light included, make sure you add a few to your cart in the perfect color for your space.How to UseOur round hooks are easy to use and install as long as you follow all of our recommendations and directions. If your support structure is mounted directly on a ceiling-joist or other wood piece, the hooks can be screwed directly into the material. For drywall mounting, please use the anchor included in the hook set. All other materials, including plaster, concrete, or brick, need to be installed with the help of a professional. Reach out to your local hardware store for advice on finding the right screw and anchor that your project would require.Selection & CustomizationColor Cord Company is all about providing you with the tools to customize everything about your lighting fixtures. Our hooks are no different and are available in a variety of finishes including:Polished CopperSolid Raw BrassBrushed NickelRaw MetalMatte WhiteMatte BlackIf you're looking at one of our raw metal finishes, please note that these styles will oxidize and rust. The intention is to allow them to blend seamlessly with any upcycled, industrial-style enhancements to your space.Our raw finishes are also the ideal choice for anyone who wants to paint these round hooks in a specific color. Simply sand the hook and apply the paint of your choice.Shop all our lighting supplies today to mix and match our accessories and design the perfect creation!

Technical Specs

- Exclusive Color Cord Company design
- Overall Height: 2 ⅜"
- Overall Width: 1 ½"
- Internal Width at Widest Point: 1"
- Max Weight Load: 10 Lbs. with Included Anchor
- Mini Set Screw to Secure Hook to Backplate
- Comes with hook, backplate, #6 wood screw & Anchor, Allen Key

Type:

AP01

ARUP

Project Number: 271565
Phone: 1 212 896 3000

COLOR CORD COMPANY

Contact: 1-800-409-1070 or info@colorcord.com

Type:

AP01

Pinch Swag Hook / Raw Metal

Price: $15.00 - Item Number: PHK-100-998

Overview

Modern Design Hooks for Hanging LightsOne of our most popular products, the Pinch Swag Hook is custom-designed to take your lighting fixture to new heights with a sleek finish that will complement your modern fixture design. The hook is specifically designed for our color cords with a quarter-inch opening and a set screw to secure the cord placement and provide some strain relief. Elevate your swag fixture with this modern take on a classic hook for hanging your new lights.Ease of Use for Walls & Ceilings:The ceiling hooks can be mounted directly on wood or ceiling-joist. For mounting on drywall, please be sure to use the included anchor. If the ceiling is made of plaster, brick, or concrete then we recommend that you consult with your local hardware store for assistance.If you are interested in the raw metal finish, please be aware that this style is intended to oxidize and rust to match industrial and upcycled applications. However, this is also the best finish to paint after sanding.Hooks for Hanging Lights That Match Your StyleWhether you want your hook to act as an accent piece with a pop of color or you want it to blend in with your pendant cord, you can choose an option that suits your design tastes. With bold colors and a variety of metal finishes, you can choose the perfect one for your decor. We have colors that look great with all our cord color options. It's easy to find pendant light accessories that match all your design tastes and work perfectly with your cord color choices.If you're looking for classic hooks for hanging lights, be sure to explore all our swag hooks to get the perfect designs for your lamps.

Technical Specs

- Exclusive Color Cord Company design
- 6 different finishes
- Overall Height: 1-27/32in
- Overall Width: 5/8in
- 17/64in opening
- Max weight load: 10 pounds with included anchor
- Features mini set screw to secure hook to backplate
- Additional mini set screw to lock in pendant cord swag position
- Comes with hook, backplate, #6 wood screw and anchor, allen key

ARUP
Project Number: 271565
Phone: 1 212 896 3000

elecDirect.com PENNUNION CONNECTING YOUR TOMORROW™ MECHANICAL CONNECTORS

Type: AP01

Copper Alloy Split Bolt Connectors

Types S and SEL

- Manufactured from high strength copper alloy - highly resistant to corrosion and season cracking
- For use with a wide range of copper solid, compact, compressed, concentric, copperweld conductors, and rebar
- Approved for electrical power, grounding/bonding, and direct burial applications

Application/Use:

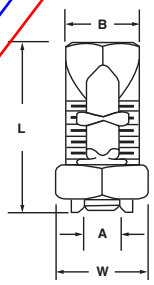
- **Type S** is for use with two conductors in electrical power applications; 2 conductors or conductor to rebar in grounding/bonding and direct burial applications in earth and concrete
- **Type SEL** is for use with two or three conductors in electrical power, grounding/bonding, and direct burial applications in earth and concrete
- DB permanately marked on head for conductor sizes up to 500 kcmil

High Quality Design:

- True hex design allows easy installation with standard tooling
- Under torque, this design provides high contact pressure between conductors or conductor to rebar
- Pressure bar design features give assurance of high "pull-out" and secure connection on all combinations of conductors
- Wide wire range
- Rated for copper conductors, 600 V, 90°C

Installation:

- Use with torque wrench, standard socket, box or open-end wrenches
- Reusable with proper installation practice



Test conductor size installed in connector		Tightening torque, N·m (lbf-in)							
		Slotted head No. 10 and larger*				Hexagonal head – external drive socket wrench			
		Slot width – 1.2 mm (0.047 in) or less and slot length – 6.4 mm (1/4 in) or less		Slot width – over 1.2 mm (0.047 in) or slot length – over 6.4 mm (1/4 in)		Split-bolt connectors		Other connectors	
AWG or kcmil	(mm²)	A	B	A	B	A	B	A	B
30 – 10	(0.05 – 5.3)	1.7 (15)	2.3 (20)	2.8 (25)	4.0 (35)	7.3 (65)	9.0 (80)	6.8 (60)	8.5 (75)
8	(8.4)	2.3 (20)	2.8 (25)	3.4 (30)	4.5 (40)	7.3 (65)	9.0 (80)	6.8 (60)	8.5 (75)
6 – 4	(13.2 – 21.2)	2.8 (25)	4.0 (35)	4.0 (35)	5.1 (45)	15.3 (135)	18.6 (165)	10.2 (90)	12.4 (110)
3	(26.7)	2.8 (25)	4.0 (35)	4.5 (40)	5.6 (50)	25.4 (225)	31.1 (275)	14.1 (125)	16.9 (150)
2	(33.6)	3.4 (30)	4.5 (40)	4.5 (40)	5.6 (50)	25.4 (225)	31.1 (275)	14.1 (125)	16.9 (150)
1	(42.4)	–	–	4.5 (40)	5.6 (50)	25.4 (225)	31.1 (275)	14.1 (125)	16.9 (150)
1/0 – 2/0	(53.5 – 67.4)	–	–	4.5 (40)	5.6 (50)	35.6 (315)	43.5 (385)	16.9 (150)	20.3 (180)
3/0 – 4/0	(85.0 – 107.2)	–	–	4.5 (40)	5.8 (50)	45.2 (400)	56.5 (500)	22.6 (200)	28.2 (250)
250 – 350	(127 – 177)	–	–	4.5 (40)	5.8 (50)	62.1 (550)	73.4 (650)	28.2 (250)	36.7 (325)
400	(203)	–	–	4.5 (40)	5.6 (50)	78.3 (675)	93.2 (825)	28.2 (250)	36.7 (325)

Continued on next page…

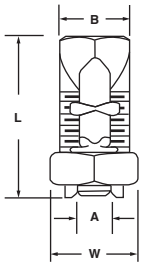
Toll Free Tel: 1.800.701.0975 • Toll Free Fax: 1.800.892.6360 • orders@elecdirect.com

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:

AP01

MECHANICAL CONNECTORS PENNUNION CONNECTING YOUR TOMORROW elecDirect.com



UL SP RUS ACCEPTED RoHS COMPLIANT

Type S - Two Conductors

CATALOG NUMBER	RANGE OF EQUAL RUN & TAP	MIN. TAP W/ ONE MAX. MAIN	MAX. CONDUCTOR COPPERWELD		UL ONLY REBAR W/ 6 OR 8 AWG	APPROXIMATE DIMENSIONS (IN.)				TORQUE (IN-LBS)
			STR.	TYPE A		L	W	B	A	
S-10*	16 Str. - 10 Str.	16 Str.	-	-	-	.72	.50	.34	.13	80
S-8*	16 Str. - 8 Str.	16 Str.	-	-	-	.84	.50	.38	.15	80
S-6*	10 Sol. - 6 Sol.	16 Sol.	-	-	-	1.05	.63	.50	.17	165
S-4*	8 Sol. - 4 Sol.	16 Sol.	3 No. 12	8A	-	1.05	.69	.56	.22	165
S-3*	6 Sol. - 2 Sol.	12 Sol.	3 No. 9	5A	-	1.32	.81	.69	.33	275
S-2*	6 Sol. - 2 Str.	14 Str.	3 No. 7	3A	-	1.32	.81	.69	.33	275
S-1/0*	4 Sol. - 1/0 Str.	14 Sol.	3 No. 6	2A	-	1.64	.88	.75	.38	385
S-2/0	2 Sol. - 2/0 Str.	14 Str.	3 No. 5	-	#3 (3/8)	1.82	1.00	.81	.42	385
S-3/0	2 Sol. - 3/0 Str.	12 Sol.	7 No. 7	-	-	2.00	1.13	.88	.47	500
S-4/0-250	1/0 Sol. - 250 kcmil	10 Sol.	7 No. 5	-	#4 (1/2)	2.08	1.31	1.00	.58	650
S-350+	4/0 Str. - 350 kcmil	8 Sol.	19 No. 7	-	#5 (5/8)	2.63	1.63	1.50	.75	650
S-500+	250 - 500 kcmil	8 Sol.	19 No. 6	-	#6 (3/4)	3.00	1.81	1.63	.83	825
S-750++	350 - 750 kcmil	8 Sol.	19 No. 5	-	-	3.75	2.13	1.94	1.03	1000
S-1000++	500 - 1000 kcmil	8 Sol.	-	-	-	4.00	2.50	2.25	1.22	1100

+UL Only Grounding, Bonding, Direct Burial (350 & 500)
++Not Approved Grounding, Bonding, Direct Burial
* RUS REA Accepted

Type SEL - Two or Three Conductors

UL SP RUS ACCEPTED RoHS COMPLIANT

CATALOG NUMBER	RANGE OF EQUAL RUN & TAP	MIN. TAP W/ ONE MAX. MAIN	MAX. CONDUCTOR COPPERWELD		APPROXIMATE DIMENSIONS (IN.)				TORQUE (IN-LBS)
			STR.	TYPE A	L	W	B	A	
SEL-8*	16 Str. - 8 Str.	16 Str.	-	-	.84	.50	.38	.14	80
SEL-6*	10 Sol. - 6 Sol.	16 Sol.	-	-	1.09	.63	.50	.17	165
SEL-4*	8 Sol. - 4 Sol.	16 Sol.	3 No. 12	8A	1.27	.69	.56	.22	165
SEL-2*	6 Sol. - 2 Str.	14 Str.	3 No. 7	3A	1.55	.81	.69	.33	275

CONNECTOR TYPE	POWER	UL-467 GROUNDING			CSA C22.2 NO. 41 GROUNDING		
	UL 486A-B CSA 22.2 NO. 65 WIRE RANGE	UL GROUNDING MAX. WIRE	GROUNDING & BONDING	DIRECT BURIAL REBAR	CSA GROUNDING MAX. WIRE	GROUNDING & BONDING	DIRECT BURIAL
S SEL	16 Str. - 1000 kcmil	500 kcmil	Yes	Yes	250 kcmil	Yes	Yes

Toll Free Tel: 1.800.701.0975 • Toll Free Fax: 1.800.892.6360 • orders@elecdirect.com

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:

AP01

SORAA vivid™

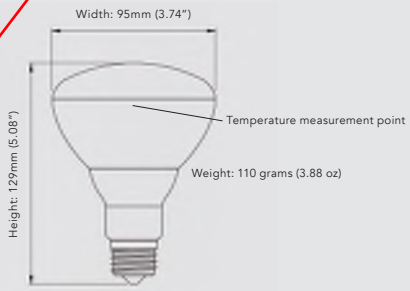
BR30 11.5W

HIGH COLOR QUALITY, ENCLOSED FIXTURE COMPATIBLE LED LAMP FOR USE IN BR30 COMPATIBLE DOWNLIGHTS AND OTHER INDOOR AND OUTDOOR APPLICATIONS

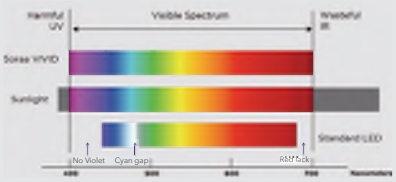
OUTPUT RANGE	725 – 750 lumen
BEAM ANGLE	120°
COLOR METRICS	**CCTs:** 2700K, 3000K Color Rendering CIE Metrics: CRI 95, R9 95 TM30 Metrics: Rf 90, Rfh1 90 Whiteness Index: Rw 100
APPLICATION	Halogen replacement for indoor and outdoor applications

vivid color · whites · IR · UV · dimmable · 120V AC · E26 · damp rated

FORM FACTOR



COLOR RENDERING



LIFETIME AND WARRANTY

Rated lifetime to L70: 25,000 hours
Warranty: 3 years or 25,000 hours whichever comes first
Detailed warranty information available at:
soraa.com/resources/legal

SORAA
SIMPLY PERFECT LIGHT

OUR LIGHT IS PERFECT BECAUSE WE INVENTED IT TO BE

We design the smallest sources and pair them with our unique full spectrum technology, for perfect color and light distribution in a range of lamp form factors.

SORAA VIVID COLOR™

Soraa lamps provide beautiful and accurate color rendering across the entire visible spectrum, with CRI/95, R9/95, Rf/90, Rg/100

SORAA NATURAL WHITE™

Soraa lamps clearly differentiate infinite shades of white; whiteness rendering matches or exceeds halogen and incandescent sources at 2700K and 3000K.

FLICKER

Soraa lamps demonstrate low levels of flicker, achieving <30% flicker in both dimmed and undimmed states.

THERMALLY COMPATIBLE

Suitable for use in fully enclosed fixtures, subject to the maximum heatsink temperature limits stated in this data sheet. A list of qualified enclosed fixtures can be found at www.soraa.com/resources. Soraa lamps are designed to safely turn down in any thermal environment not conducive to minimum airflow or proper ventilation.

ELECTRICALLY COMPATIBLE

Works with trailing edge and leading edge phase cut dimmers. A list of compatible dimmers and transformers can be found at www.soraa.com/resources/compatibility.

LOCATION RATING

Suitable for damp locations
Not rated for use in wet locations, should not be exposed to liquid water (including condensation).

ARUP
Project Number: 271565
Phone: 1 212 896 3000

SORAA vivid™

BR30 11.5W

Type:

AP01

OPERATING TEMPERATURE

Minimum: -40˚ C (ambient)
Typical: 65˚ C - 80˚ C (lamp base)
Maximum: 90˚ C (lamp base)

ELECTRICAL SPECIFICATIONS

Wattage: 11.5W
Voltage: 120V +/- 12V
Frequency: 50/60 Hz
Power Factor: 0.95

DIMMING AND FLICKER

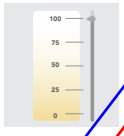
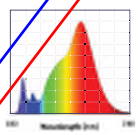
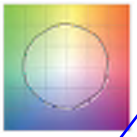
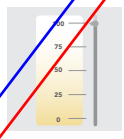
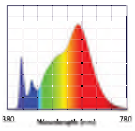
T24/JA8 compliant.

Please reference our compatibility chart for dimmer and transformer information.

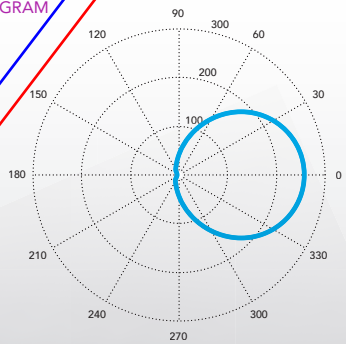
CERTIFICATIONS

UL/CUL
FCC Title 47 Part 15B
RoHS

c UL us **RoHS**

SERIES/CCT	COLOR ACCURACY	WHITENESS INDEX	SPECTRAL POWER DISTRIBUTION
VIVID 2700K	Rf: 90, Rg: 100, Rfh1: 90	 Rw: 100	 CRI: 95, R9: 95
VIVID 3000K	 Rf: 90, Rg: 100, Rfh1: 90	 Rw: 100	 CRI: 95, R9: 95

POLAR DIAGRAM



Model Number	Product Code	CCT (K)	Total Flux (Lm)	Beam Angle (˚)	Halogen Equiv (W)**	Efficacy (Lm/W)	CRI/R9	Rf	White Point (McA)
VIVID SERIES									
SB30-11-120D-927-01	04216	2700	725	120	65	62	95 / 95	90	3
SB30-11-120D-930-01	04218	3000	750	120	65	65	95 / 95	90	3

*Specifications are at stable warm operating conditions (25°C ambient) **Energy Star Minimum
CCT = Correlated Color Temperature CRI = Color Rendering Index (Ra-8) White Point = White Point Accuracy in McA step

SORAA
SIMPLY PERFECT LIGHT

Information and specifications subject to change. BR30 11.5W Rev 2 4.2.19
Soraa Inc. 6500 Kaiser Drive, Suite 110, Fremont, CA 94555 www.soraa.com

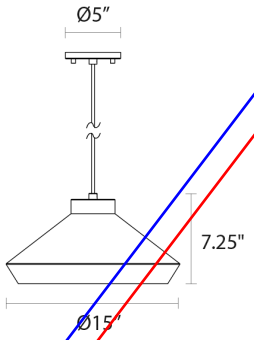
ARUP
Project Number: 271565
Phone: 1 212 896 3000

SONNEMAN
A WAY OF LIGHT

Type:

AP01

koma Meiji Pendant w/E26 Base **2752.25-E**



DIMENSIONS

Height	7.25"
Diameter	15"
Canopy/Backplate/Base	5"
Switch Type	N/A"
Hanging Details	10' Adj. Black Silk Cord"

ELECTRICAL SPECS

Bulb Type	Medium Base
Bulb Quantity	1
Bulb Included?	No
Wattage	75
Initial Lumens	0
Power Supply Quantity	0

SHIPPING

Carton 1 L x W x H	19" x 19" x 10"
Carton 1 GW	5 lbs.

SHADE 1

Color	Satin Black w/White Interior
Material	Aluminum
Height	7.25"
Diameter	15

AVAILABLE FINISHES

Satin White (.03)
Bright Satin Aluminum (.16)
Satin Black (.25)

GENERAL LISTINGS

cETL
cUL
Location

PROJECT

QUANTITY

NOTES

SONNEMAN - A Way of Light | 151 Airport Drive, Wappingers Falls, NY 12590 | www.sonnemanawayoflight.com

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page Remove page

Manufacturer: BEGA : 22248
Description: Recessed Wall Light

Fixture Wattage: 3.9 W
Lumen Output: 159 lumen
Lamp CRI: 80+
Lighting Controls: 0-10V Dimming

Voltage: 120 V
Fixture Finish: Dark Grey
Lamp CCT: 2700K
Assembly Code: 22248-K27

LED recessed wall - shielded

BEGA

Type:

AW02

Type:
BEGA Product:
Project:
Modified:

Application
Designed for low mounting heights for interior and exterior locations, the shielded light distribution is ideal for the glare-free illumination of ground surfaces, building entrances, stairs, and footpaths.

Materials
Luminaire housing and faceplate constructed of die-cast marine grade, copper free (≤ 0.3% copper content) A360.0 aluminum alloy
White safety glass
High temperature silicone gasket
Mechanically captive stainless steel fasteners

NRTL listed to North American Standards, suitable for wet locations
Protection class IP 65
Weight: 2.2 lbs

Electrical

Operating voltage	120-277 V AC
Minimum start temperature	-30° C
LED module wattage	3.9 W
System wattage	6.0 W
Controllability	0-10V dimmable
Color rendering index	Ra > 90
Luminaire lumens	159 lumens (3000K)
Lifetime at Ta = 15° C	>500,000 h (L70)
Lifetime at Ta = 45° C	172,000 h (L70)

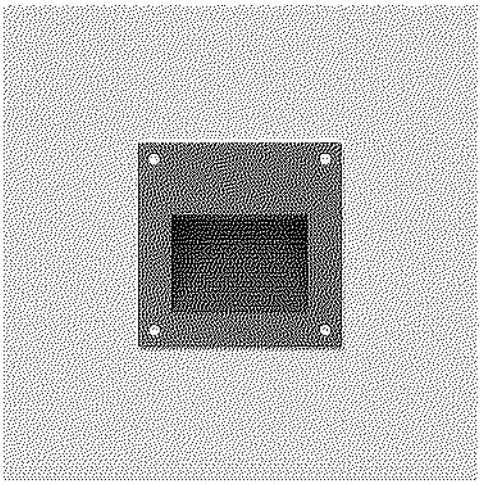
LED color temperature

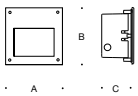
☐ 4000K - Product number + **K4**
☐ 3500K - Product number + **K35**
☑ 3000K - Product number + **K3 (*EXPRESS*)**
☐ 2700K - Product number + **K27**
☐ Amber - Product number + **AMB**

BEGA can supply you with suitable LED replacement modules for up to 20 years after the purchase of LED luminaires - see website for details

Finish
All BEGA standard finishes are matte, textured polyester powder coat with minimum 3 mil thickness.

Available colors ☐ Black (BLK) ☐ White (WHT) ☑ RAL:
☐ Bronze (BRZ) ☐ Silver (SLV) ☐ CUS:





LED recessed wall · shielded

		LED	A	B	C
22272	ADA	3.9 W	5 7/8	5 7/8	4 1/8

Lighting Notes:

1. Finish to be confirmed by architect.
2. Coordinate mounting height above grade with architectural drawings. Fixture to be at least 3ft AFFL to avoid being covered in snow during winter.

BEGA 1000 BEGA Way, Carpinteria, CA 93013 (805) 684-0533 info@bega-us.com

Due to the dynamic nature of lighting products and the associated technologies, luminaire data on this sheet is subject to change at the discretion of BEGA North America. For the most current technical data, please refer to bega-us.com
© copyright BEGA 2018

Updated 12/13/19

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Manufacturer: iGuzzini : Palco In Out
Description: Surface Mounted Spotlight (Low Voltage)

Fixture Wattage:	9 W	**Voltage:**	24 V
Lumen Output:	653 lumen	**Fixture Finish:**	Silver
Lamp CRI:	90+	**Lamp CCT:**	3000K
Lighting Controls:	0-10V Dimming	**Assembly Code:**	EH97

Type:
AWS02a

Palco InOut

Design Artec3 Studio iGuzzini

Last information update: October 2020

Product configuration: EH97
EH97: Spotlight with base - Warm White Led - integrated electronic control gear - Very Wide Flood optic

Product code
EH97: Spotlight with base - Warm White Led - integrated electronic control gear - Very Wide Flood optic

Technical description
Spotlight designed to use LED lamps and a Very Wide Flood optic. The optical assembly and base is made of EN1706AC 46100LF aluminium alloy and subjected to a multi-step, pre-treatment process, in which the main phases are degreasing, fluorozirconation (a protective surface film) and sealing (with a nano-structured silane layer). The following painting stage consists of a primer and a liquid acrylic paint, cured at 150°C, with a high level of weather and UV ray resistance. 5 mm thick tempered sodium-calcium closing glass. Double adjustability allows a 360° rotation about the vertical axis and 90° tilting relative to the horizontal plane. Mechanical aiming locks for rotation on both the vertical axis and horizontal plane. Complete with a monochrome LED circuit and an Opti Beam Reflector optic system. The product includes a PG13.5 cable gland. Electronic On/Off ballast integrated in product. Option of using optic accessories assembled via an accessory holder frame. All external screws used are made of A2 stainless steel.

Installation
Floor, wall, ceiling or ground-installed via pole or stake.

Colour
White (01) | Grey (15)

Weight (Kg)
1.9

Mounting
wall surface|ground spike

Wiring
Double PG.

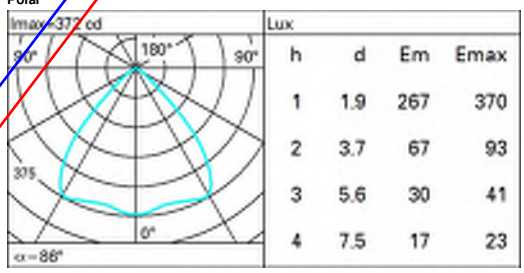
Complies with EN60598-1 and pertinent regulations

IK07 IP66

Technical data

lm system:	653	Life Time LED 1:	65,000h - L80 - B10 (Ta 25°C)
W system:	10.9	Life Time LED 2:	65,000h - L80 - B10 (Ta 40°C)
lm source:	920	Ballast losses [W]:	1.8
W source:	9.1	Lamp code:	LED
Luminous efficiency (lm/W, real value):	59.9	Number of lamps for optical assembly:	1
lm in emergency mode:	-	ZVEI Code:	LED
Total light flux at or above an angle of 90° [Lm]:	0	Number of optical assemblies:	1
Light Output Ratio (L.O.R.) [%]:	71	Ambient operating temperature range:	from -20°C to 50°C.
Beam angle [°]:	86°	Lifetime of product at ambient operating temperature:	≥ 50.000h Ta=40°C
CRI:	80	Power factor:	See installation instructions
Colour temperature [K]:	3000	Overvoltage protection:	2kV Common mode & 1kV Differential mode
MacAdam Step:	2	Control:	On/off

Polar



h	d	Em	Emax
1	1.9	267	370
2	3.7	67	93
3	5.6	30	41
4	7.5	17	23

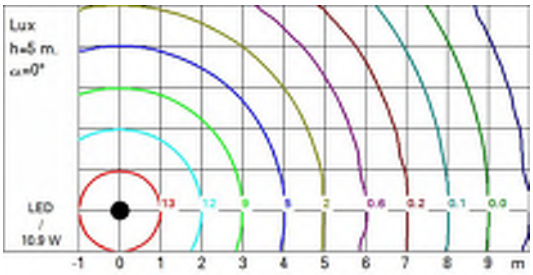
EH97_EN 1 / 2

Lighting Notes:

1. Finish to be confirmed by architect.
2. Contractor to coordinate mounting with architect.
3. Contractor to coordinate with architect and lighting consultant for final aiming and focus for adjustable fixtures.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Isolux



UGR diagram

Corrected UGR values (at 920 lm bare lamp luminous flux)

Reflect.: ceil/cav	0.70	0.70	0.50	0.50	0.30	0.70	0.70	0.50	0.50	0.30
walls	0.50	0.30	0.50	0.30	0.30	0.50	0.30	0.50	0.30	0.30
work pl.	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Room dim.			viewed crosswise					viewed endwise		
x	y									
2H	2H	23.9	24.7	24.2	24.9	25.1	23.9	24.7	24.2	24.9	25.1
	3H	23.8	24.5	24.1	24.7	25.0	23.8	24.5	24.1	24.7	25.0
	4H	23.7	24.3	24.1	24.6	24.9	23.7	24.4	24.1	24.6	25.0
	6H	23.6	24.2	24.0	24.5	24.9	23.7	24.2	24.0	24.5	24.9
	8H	23.6	24.1	24.0	24.5	24.8	23.6	24.2	24.0	24.5	24.8
	12H	23.6	24.1	23.9	24.4	24.8	23.6	24.1	24.0	24.4	24.8
4H	2H	23.7	24.4	24.1	24.6	25.0	23.7	24.3	24.1	24.6	24.9
	3H	23.6	24.1	24.0	24.5	24.8	23.6	24.1	24.0	24.5	24.8
	4H	23.5	24.0	23.9	24.3	24.7	23.5	24.0	23.9	24.3	24.7
	6H	23.4	23.8	23.9	24.2	24.7	23.4	23.8	23.9	24.2	24.7
	8H	23.4	23.8	23.8	24.2	24.6	23.4	23.8	23.8	24.2	24.6
	12H	23.3	23.7	23.8	24.1	24.6	23.3	23.7	23.8	24.1	24.6
6H	4H	23.4	23.8	23.8	24.2	24.6	23.4	23.8	23.8	24.2	24.6
	6H	23.3	23.6	23.8	24.0	24.5	23.3	23.6	23.8	24.0	24.5
	8H	23.3	23.5	23.7	24.0	24.5	23.3	23.5	23.7	24.0	24.5
	12H	23.2	23.4	23.7	23.9	24.4	23.2	23.4	23.7	23.9	24.4
12H	4H	23.3	23.7	23.8	24.1	24.6	23.3	23.7	23.8	24.1	24.6
	6H	23.3	23.5	23.7	24.0	24.5	23.3	23.5	23.7	24.0	24.5
	8H	23.2	23.4	23.7	23.9	24.4	23.2	23.4	23.7	23.9	24.4

Variations with the observer position at spacing:

S =			
	1.0H	2.7 / -7.1	2.7 / -7.1
	1.5H	4.8 / -11.5	4.8 / -11.5
	2.0H	6.8 / -13.9	6.8 / -13.9

Type:

AWS02a

ARUP
Project Number: 271565
Phone: 1 212 896 3000

EH97_EN 2 / 2

Remove page Remove page

Manufacturer: iGuzzini : Palco In Out
Description: Surface Mounted Spotlight (Low Voltage)

Fixture Wattage: 16 W
Lumen Output: 1806 lumen
Lamp CRI: 90+
Lighting Controls: 0-10V Dimming

Voltage: 24 V
Fixture Finish: Silver
Lamp CCT: 3000K
Assembly Code: Q719

Type:
AWS03a

Palco InOut

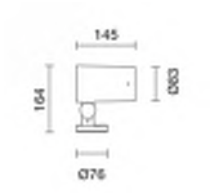
Design Artec3 Studio iGuzzini

Last information update: October 2020

Product configuration: Q719
Q719: Spotlight with base - Warm White Led - Class III - Very Wide Flood optic

Product code
Q719: Spotlight with base - Warm White Led - Class III - Very Wide Flood optic

Technical description
Spotlight designed to use LED lamps and a Very Wide Flood optic. The optical assembly and base is made of EN1706AC 46100LF aluminium alloy and subjected to a multi-step, pre-treatment process, in which the main phases are degreasing, fluorozirconation (a protective surface film) and sealing (with a nano-structured silane layer). The following painting stage consists of a primer and a liquid acrylic paint, cured at 150°C, with a high level of weather and UV ray resistance. 5 mm thick tempered sodium-calcium closing glass. Double adjustability allows a 360° rotation about the vertical axis and 90° tilting relative to the horizontal plane. Mechanical aiming locks for rotation on both the vertical axis and horizontal plane. Complete with a monochrome LED circuit and an Opti Beam Reflector optic system. The product includes a PG13.5 cable gland. Black rubber outlet cable complete with anti-transpiration device. Black rubber outlet cable complete with anti-transpiration device. Electronic ballast to be ordered separately. Option of using optic accessories assembled via an accessory holder frame. All external screws used are made of A2 stainless steel.



Installation
Floor, wall, ceiling or ground-installed via a stake.

Colour
White (01) | Grey (15)

Weight (Kg)
1.3

Mounting
wall surface|ground spike

Wiring
The product is supplied with a black rubber outlet cable complete with anti-transpiration device L=1000mm.

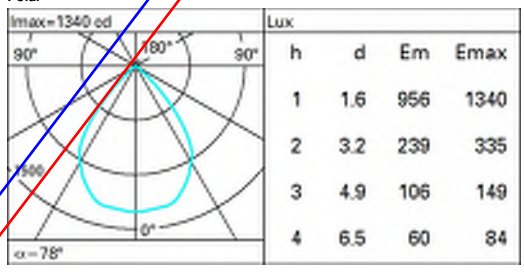
Complies with EN60598-1 and pertinent regulations

IK07 IP66

Technical data

lm system:	1806	MacAdam Step:	2
W system:	16	Life Time LED 1:	100,000h - L80 - B10 (Ta 25°C)
lm source:	2150	Ballast losses [W]:	0
W source:	16	Lamp code:	LED
Luminous efficiency (lm/W, real value):	112.9	Number of lamps for optical assembly:	1
lm in emergency mode:	-	ZVEI Code:	LED
Total light flux at or above an angle of 90° [Lm]:	0	Number of optical assemblies:	1
Light Output Ratio (L.O.R.) [%]:	84	Ambient operating temperature range:	from -30°C to 35°C.
Beam angle [°]:	78°	Lifetime of product at ambient operating temperature:	≥ 50.000h Ta=25°C
CRI:	80		
Colour temperature [K]:	3000	LED Currente:	470

Polar



Lighting Notes:

1. Finish to be confirmed by architect.
2. Contractor to coordinate mounting with Architect.
3. Contractor to coordinate with Architect and Lighting Consultant for final aiming and focus for adjustable fixtures.

Q719_EN 1 / 2

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page

Remove page

Isolux

UGR diagram

Corrected UGR values (at 2750 lm bare lamp luminous flux)

Reflect.: ceil/cav		0.70	0.70	0.50	0.50	0.30	0.70	0.70	0.50	0.50	0.30
walls		0.50	0.30	0.50	0.30	0.30	0.50	0.30	0.50	0.30	0.30
work pl.		0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Room dim.				viewed crosswise					viewed endwise		
x	y										
2H	2H	28.1	28.9	28.4	27.1	27.3	28.1	28.9	28.4	27.1	27.3
	3H	28.0	28.6	28.3	26.9	27.2	28.0	28.6	28.3	26.9	27.2
	4H	25.9	28.5	28.2	26.8	27.1	25.9	28.5	28.2	26.8	27.1
	6H	25.8	28.4	28.2	26.7	27.0	25.8	28.4	28.2	26.7	27.0
	8H	25.8	28.3	28.2	26.7	27.0	25.8	28.3	28.2	26.7	27.0
	12H	25.8	28.3	28.1	26.6	27.0	25.8	28.3	28.1	26.6	27.0
4H	2H	25.9	28.5	28.2	26.6	27.1	25.9	28.5	28.2	26.6	27.1
	3H	25.8	28.3	28.1	26.6	27.0	25.8	28.3	28.1	26.6	27.0
	4H	25.7	28.1	28.1	26.5	26.9	25.7	28.1	28.1	26.5	26.8
	6H	25.6	28.0	28.0	26.4	26.8	25.6	28.0	28.0	26.4	26.8
	8H	25.5	25.9	28.0	26.3	26.7	25.5	25.9	28.0	26.3	26.7
	12H	25.5	25.8	25.9	26.2	26.7	25.5	25.8	25.9	26.2	26.7
6H	4H	25.5	25.9	28.0	26.3	26.7	25.5	25.9	28.0	26.3	26.7
	6H	25.4	25.7	25.9	26.2	26.7	25.4	25.7	25.9	26.2	26.7
	8H	25.4	25.6	25.9	26.1	26.6	25.4	25.6	25.9	26.1	26.6
	12H	25.3	25.6	25.8	26.0	26.6	25.3	25.6	25.8	26.0	26.6
12H	4H	25.5	25.8	25.9	26.2	26.7	25.5	25.8	25.9	26.2	26.7
	6H	25.4	25.6	25.9	26.1	26.6	25.4	25.6	25.9	26.1	26.6
	8H	25.3	25.6	25.8	26.0	26.6	25.3	25.6	25.8	26.0	26.6

Variations with the observer position at spacing:

S =			
	1.0H	3.2 / -16.6	3.2 / -16.6
	1.5H	5.5 / -23.3	5.5 / -23.3
	2.0H	7.5 / -25.3	7.5 / -25.3

Type:

AWS03a

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Q719_EN 2 / 2

Remove page

Remove page

Type:

Welcome Pavilion

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Manufacturer: iGuzzini : Palco In Out
Description: Surface Mounted Spotlight (Low Voltage) Remove page

Remove page

Fixture Wattage:	16 W	**Voltage:**	48 V
Lumen Output:	1806 lumen	**Fixture Finish:**	Grey
Lamp CRI:	80+	**Lamp CCT:**	2700K
Lighting Controls:	0-10V Dimming	**Assembly Code:**	Q719

Palco InOut

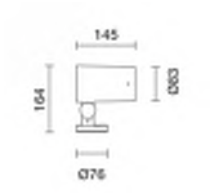
Design Artec3 Studio iGuzzini

Last information update: October 2020

Product configuration: Q719
Q719: Spotlight with base - Warm White Led - Class III - Very Wide Flood optic

Product code
Q719: Spotlight with base - Warm White Led - Class III - Very Wide Flood optic

Technical description
Spotlight designed to use LED lamps and a Very Wide Flood optic. The optical assembly and base is made of EN1706AC 46100LF aluminium alloy and subjected to a multi-step, pre-treatment process, in which the main phases are degreasing, fluorozirconation (a protective surface film) and sealing (with a nano-structured silane layer). The following painting stage consists of a primer and a liquid acrylic paint, cured at 150°C, with a high level of weather and UV ray resistance. 5 mm thick tempered sodium-calcium closing glass. Double adjustability allows a 360° rotation about the vertical axis and 90° tilting relative to the horizontal plane. Mechanical aiming locks for rotation on both the vertical axis and horizontal plane. Complete with a monochrome LED circuit and an Opti Beam Reflector optic system. The product includes a PG13.5 cable gland. Black rubber outlet cable complete with anti-transpiration device. Black rubber outlet cable complete with anti-transpiration device. Electronic ballast to be ordered separately. Option of using optic accessories assembled via an accessory holder frame. All external screws used are made of A2 stainless steel.



Installation
Floor, wall, ceiling or ground-installed via a stake.

Colour
White (01) | Grey (15)

Weight (Kg)
1.3

Mounting
wall surface|ground spike

Wiring
The product is supplied with a black rubber outlet cable complete with anti-transpiration device L=1000mm.

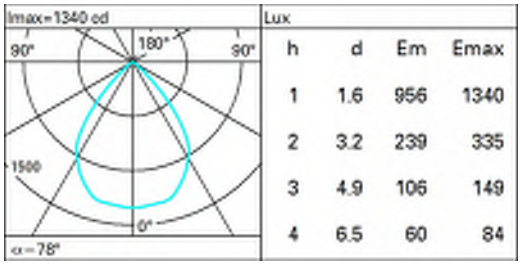
Complies with EN60598-1 and pertinent regulations

IK07 IP66

Technical data

lm system:	1806	MacAdam Step:	2
W system:	16	Life Time LED 1:	100,000h - L80 - B10 (Ta 25°C)
lm source:	2150	Ballast losses [W]:	0
W source:	16	Lamp code:	LED
Luminous efficiency (lm/W, real value):	112.9	Number of lamps for optical assembly:	1
lm in emergency mode:	-	ZVEI Code:	LED
Total light flux at or above an angle of 90° [Lm]:	0	Number of optical assemblies:	1
Light Output Ratio (L.O.R.) [%]:	84	Ambient operating temperature range:	from -30°C to 35°C.
Beam angle [°]:	78°	Lifetime of product at ambient operating temperature:	≥ 50.000h Ta=25°C
CRI:	80		
Colour temperature [K]:	3000	LED Currente:	470

Polar



Q719_EN 1 / 2

Type:
AWS03

Lighting Notes:

1. Fixture finish to be confirmed by architect.
2. Contractor to coordinate mounting with Architect.
3. Contractor to coordinate with Architect and Lighting Consultant for final aiming and focus for adjustable fixtures.
4. Contractor to coordinate location for remote driver in nearest weather proof location.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page

Remove page

Isolux

UGR diagram

Corrected UGR values (at 2750 lm bare lamp luminous flux)

Reflect.: ceil/cav	0.70	0.70	0.50	0.50	0.30	0.70	0.70	0.50	0.50	0.30
walls	0.50	0.30	0.50	0.30	0.30	0.50	0.30	0.50	0.30	0.30
work pl.	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Room dim.			viewed crosswise					viewed endwise		
x	y									
2H	2H	28.1	28.9	28.4	27.1	27.3	28.1	28.9	28.4	27.1	27.3
	3H	28.0	28.8	28.3	26.9	27.2	28.0	28.8	28.3	26.9	27.2
	4H	25.9	28.5	28.2	26.8	27.1	25.9	28.5	28.2	26.8	27.1
	6H	25.8	28.4	28.2	26.7	27.0	25.8	28.4	28.2	26.7	27.0
	8H	25.8	28.3	28.2	26.7	27.0	25.8	28.3	28.2	26.7	27.0
	12H	25.8	28.3	28.1	26.6	26.9	25.8	28.3	28.1	26.6	27.0
4H	2H	25.9	28.5	28.2	26.8	27.1	25.9	28.5	28.2	26.8	27.1
	3H	25.8	28.3	28.1	26.6	27.0	25.8	28.3	28.1	26.8	27.0
	4H	25.7	28.1	28.1	26.5	26.9	25.7	28.1	28.1	26.5	26.8
	6H	25.6	28.0	28.0	26.4	26.8	25.6	28.0	28.0	26.4	26.8
	8H	25.5	27.9	28.0	26.3	26.7	25.5	27.9	28.0	26.3	26.7
	12H	25.5	25.8	25.9	26.2	26.7	25.5	25.8	25.9	26.2	26.7
6H	4H	25.5	25.8	25.9	26.3	26.7	25.5	25.9	26.0	26.3	26.7
	6H	25.4	25.7	25.9	26.2	26.7	25.4	25.7	25.9	26.2	26.7
	8H	25.4	25.6	25.9	26.1	26.6	25.4	25.6	25.9	26.1	26.6
	12H	25.3	25.6	25.8	26.0	26.6	25.3	25.6	25.8	26.0	26.6
12H	4H	25.5	25.8	25.9	26.2	26.7	25.5	25.8	25.9	26.2	26.7
	6H	25.4	25.6	25.9	26.1	26.6	25.4	25.6	25.9	26.1	26.6
	8H	25.3	25.6	25.8	26.0	26.6	25.3	25.6	25.8	26.0	26.6

Variations with the observer position at spacing:

S =	1.0H	3.2 / -16.6	3.2 / -16.6
	1.5H	5.5 / -23.3	5.5 / -23.3
	2.0H	7.5 / -25.3	7.5 / -25.3

Type:

AWS03

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Manufacturer: iGuzzini : Palco In Out
Description: Surface Mounted Spotlight (Low Voltage)

Fixture Wattage: 16 W
Lumen Output: 1806 lumen
Lamp CRI: 80+
Lighting Controls: 0-10V Dimming

Voltage: 48 V
Fixture Finish: Silver
Lamp CCT: 3000K
Assembly Code: Q719

Palco InOut

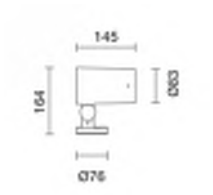
Design Artec3 Studio iGuzzini

Last information update: October 2020

Product configuration: Q719
Q719: Spotlight with base - Warm White Led - Class III - Very Wide Flood optic

Product code
Q719: Spotlight with base - Warm White Led - Class III - Very Wide Flood optic

Technical description
Spotlight designed to use LED lamps and a Very Wide Flood optic. The optical assembly and base is made of EN1706AC 46100LF aluminium alloy and subjected to a multi-step, pre-treatment process, in which the main phases are degreasing, fluorozirconation (a protective surface film) and sealing (with a nano-structured silane layer). The following painting stage consists of a primer and a liquid acrylic paint, cured at 150°C, with a high level of weather and UV ray resistance. 5 mm thick tempered sodium-calcium closing glass. Double adjustability allows a 360° rotation about the vertical axis and 90° tilting relative to the horizontal plane. Mechanical aiming locks for rotation on both the vertical axis and horizontal plane. Complete with a monochrome LED circuit and an Opti Beam Reflector optic system. The product includes a PG13.5 cable gland. Black rubber outlet cable complete with anti-transpiration device. Black rubber outlet cable complete with anti-transpiration device. Electronic ballast to be ordered separately. Option of using optic accessories assembled via an accessory holder frame. All external screws used are made of A2 stainless steel.



Installation
Floor, wall, ceiling or ground-installed via a stake.

Colour
White (01) | Grey (15)

Weight (Kg)
1.3

Mounting
wall surface|ground spike

Wiring
The product is supplied with a black rubber outlet cable complete with anti-transpiration device L=1000mm.

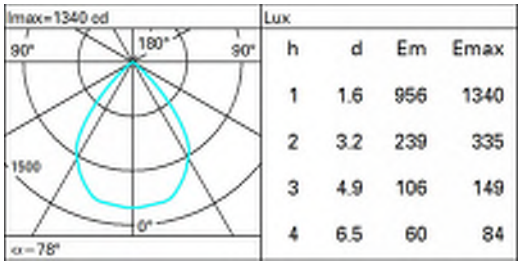
Complies with EN60598-1 and pertinent regulations

IK07 IP66

Technical data

lm system:	1806	MacAdam Step:	2
W system:	16	Life Time LED 1:	100,000h - L80 - B10 (Ta 25°C)
lm source:	2150	Ballast losses [W]:	0
W source:	16	Lamp code:	LED
Luminous efficiency (lm/W, real value):	112.9	Number of lamps for optical assembly:	1
lm in emergency mode:	-	ZVEI Code:	LED
Total light flux at or above an angle of 90° [Lm]:	0	Number of optical assemblies:	1
Light Output Ratio (L.O.R.) [%]:	84	Ambient operating temperature range:	from -30°C to 35°C.
Beam angle [°]:	78°	Lifetime of product at ambient operating temperature:	≥ 50.000h Ta=25°C
CRI:	80		
Colour temperature [K]:	3000	LED Currente:	470

Polar



Q719_EN 1 / 2

Type:
AWS03a

Page 1 of 2

Lighting Notes:

1. Fixture finish to be confirmed by architect.
2. Contractor to coordinate mounting with Architect.
3. Contractor to coordinate with Architect and Lighting Consultant for final aiming and focus for adjustable fixtures.
4. Contractor to coordinate location for remote driver in nearest weather proof location.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page

Remove page

Isolux

UGR diagram

Corrected UGR values (at 2750 lm lamp luminous flux)

Reflect.: ceil/cav		0.70	0.70	0.50	0.50	0.30	0.70	0.70	0.50	0.50	0.30
walls		0.50	0.30	0.50	0.30	0.30	0.50	0.30	0.50	0.30	0.30
work pl.		0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Room dim.				viewed crosswise					viewed endwise		
x	y										
2H	2H	28.1	28.9	28.4	27.1	27.3	28.1	28.9	28.4	27.1	27.3
	3H	28.0	28.8	28.3	26.9	27.2	28.0	28.8	28.3	26.9	27.2
	4H	25.9	28.5	28.2	26.8	27.1	25.9	28.5	28.2	26.8	27.1
	6H	25.8	28.4	28.2	26.7	27.0	25.8	28.4	28.2	26.7	27.0
	8H	25.8	28.3	28.2	26.7	27.0	25.8	28.3	28.2	26.7	27.0
	12H	25.8	28.3	28.1	26.6	27.0	25.8	28.3	28.1	26.6	27.0
4H	2H	25.9	28.5	28.2	26.8	27.1	25.9	28.5	28.2	26.8	27.1
	3H	25.8	28.3	28.1	26.6	27.0	25.8	28.3	28.1	26.6	27.0
	4H	25.7	28.1	28.1	26.5	26.9	25.7	28.1	28.1	26.5	26.9
	6H	25.6	28.0	28.0	26.4	26.8	25.6	28.0	28.0	26.4	26.8
	8H	25.5	25.9	28.0	26.3	26.7	25.5	25.9	28.0	26.3	26.7
	12H	25.5	25.8	25.8	26.2	26.7	25.5	25.8	25.9	26.2	26.7
6H	4H	25.5	25.8	28.0	26.3	26.7	25.5	25.9	28.0	26.3	26.7
	6H	25.4	25.7	25.9	26.2	26.7	25.4	25.7	25.9	26.2	26.7
	8H	25.4	25.8	25.9	26.1	26.6	25.4	25.8	25.9	26.1	26.6
	12H	25.3	25.8	25.8	26.0	26.6	25.3	25.8	25.8	26.0	26.6
12H	4H	25.5	25.8	25.9	26.2	26.7	25.5	25.8	25.9	26.2	26.7
	6H	25.4	25.8	25.9	26.1	26.6	25.4	25.8	25.9	26.1	26.6
	8H	25.3	25.8	25.8	26.0	26.6	25.3	25.8	25.8	26.0	26.6

Variations with the observer position at spacing:

S =			
	1.0H	3.2 / -10.6	3.2 / -10.6
	1.5H	5.5 / -23.3	5.5 / -23.3
	2.0H	7.5 / -25.3	7.5 / -25.3

Type:

AWS03a

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Q719_EN 2 / 2

Remove page Remove page

Manufacturer: iGuzzini : Laser Blade
Description: Recessed Linear Fixture

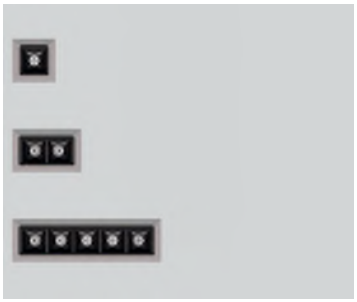
Fixture Wattage: 4 W
Lumen Output: 614 lumen
Lamp CRI: 80+
Lighting Controls: 0-10V Dimming

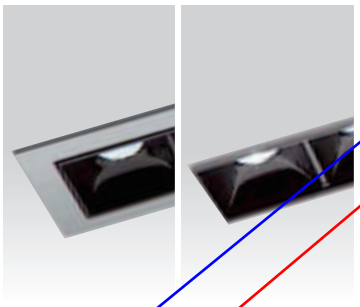
Voltage: 120 V
Fixture Finish: Silver
Lamp CCT: 3000K
Assembly Code: ILB05 TR NC 030 WF REM 10 BN LB05 TR NC

LASER BLADE ORIGINAL

DOWNLIGHT - NEW CONSTRUCTION WITH PLASTER FRAME - REMOTE

Type: **SPECIFICATION SHEET**
Project : Page: 1 of 7





Laser blade original is a collection of recessed downlights for architectural applications. The luminaires are equipped with high performance Opti Beam optics system for low luminance downlights (UGR < 10). Laser blade original is available in 5 aperture sizes, trim or trimless, 5 distributions, generous outputs of up to 2445 lumens and excellent chromatic performance .

NOW ASSEMBLED IN NORTH AMERICA.

Luminaire characteristic:	**Power input:** 3.5W to 13W (system wattage) **Lumens:** 165lm to 825lm (for 3000K, 90CRI) **Luminaire efficacy:** up to 63lm/W
Source:	White LED module (LM-80) 2700K: 95CRI, 3000K: 90CRI, 95CRI, 3500K: 95CRI, 4000K: 95CRI.
Lumen maintenance:	90% of initial lumens at 50 000 hours (L90) (LM-79).
Optics:	Low luminance: Spot, flood, wide flood and general light pro optic with Opti Beam technology.
Material:	Body and heat sink: Die-cast aluminum Reflector and baffle: Thermoplastic Plaster frame: Galvanized steel
Mounting:	New construction plaster frame suitable for insulated ceiling.
Electrical:	High efficiency LED driver, rated at 50 000 hours. See remote LED driver options on page 7.
Finish:	Black, white (RAL9010) and grey (RAL9006) (page 6).
Weight:	ILB01: 0.11lbs (0.05kg) ILB02: 0.20lbs (0.09kg) ILB05: 0.66lbs (0.30kg)
Warranty:	5 year limited warranty.
Ratings:	IP20, IP23 (from under the ceiling)
Certification:	cULus listed for damp location. Interior use only. Energy star certified product (except ILB01/ILB02). To confirm which versions are certified, please consult the product list: www.energystar.gov/productfinder **Assembled in North America.**

JP - R22 Last update: October 29, 2020 Due to continuous improvements, the information herein may be changed without notice

Type:

AL08

Page 1 of 7

Lighting Notes:

1. Contractor to coordinate remote driver quantities in accordance with manufacturer recommendations.
2. Contractor to coordinate remote driver locations in nearest possible location with architect.
3. Fixture finish to be confirmed by architect.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page

Remove page

LASER BLADE ORIGINAL

DOWNLIGHT - NEW CONSTRUCTION WITH PLASTER FRAME - REMOTE

Type:

Project :

SPECIFICATION SHEET

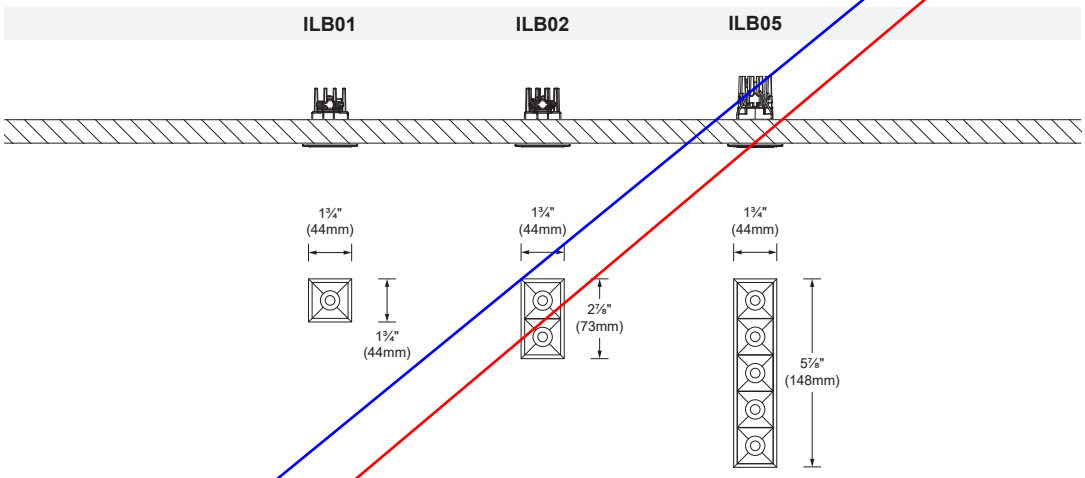
Page: 2 of 7

Type:

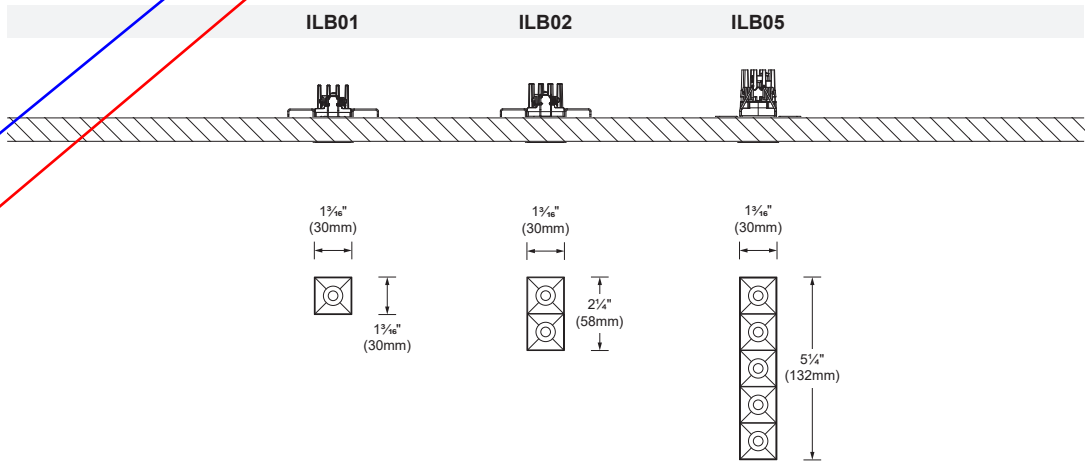
AL08

Page 2 of 7

TRIM MODELS DIMENSIONS



TRIMLESS MODELS DIMENSIONS



BOTTOM VIEW

* See page 5 for installation option details

ARUP

Project Number: 271565

Phone: 1 212 896 3000

Remove page Remove page

LASER BLADE ORIGINAL

DOWNLIGHT - NEW CONSTRUCTION WITH PLASTER FRAME - REMOTE

Type:

Project :

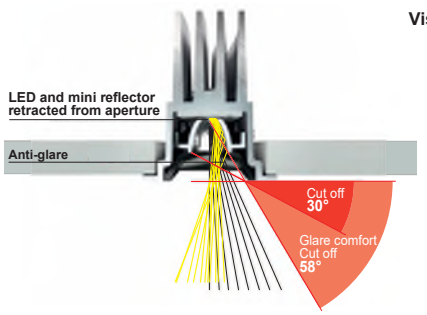
SPECIFICATION SHEET

Page: 3 of 7

Type:

AL08

Page 3 of 7



Visual comfort UGR < 10.

LED COLOR FIDELITY DATA

CRI	CCT	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	Rf	Rg	Melanopic ratio
90	3000K	91	94	96	91	91	93	92	80	54	86	91	83	92	97	97	91	100	0.535
95	2700K	100	99	94	97	99	98	99	97	89	94	96	90	100	96	98	96	101	0.503
	3000K	98	99	95	96	99	98	98	97	93	97	93	93	98	96	100	96	103	0.569
	3500K	97	94	90	95	95	92	95	96	89	86	96	84	96	94	95	98	101	0.633
	4000K	99	99	97	97	97	97	97	96	94	97	99	76	99	98	96	92	98	0.751

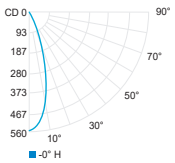
PHOTOMETRIC DATA

ILB01

CCT (K)*	CRI	LOAD (W)	OPTIC	LUMENS (lm)	EFFICACY (lm / w)	MAX CANDELA (cd)	MODELS
3000K	90	3.5W	Flood 32°	165	47	550	ILB01-930-FL

*USE MULTIPLIER TABLE FOR OTHER CCT AND CRI OUTPUT DATA

Flood 32° (3000K, 90 CRI)



	Center beam fc	Beam width ft
2ft	139	1.1
4ft	34.8	2.3
6ft	15.5	3.4
8ft	8.70	4.5
10ft	5.57	5.7
12ft	3.87	6.8

CCT options	2700K	3000K	3500K	4000K	3000K
CRI options	95CRI	95CRI	95CRI	95CRI	90CRI
Multiplier	**0.85**	**0.92**	**1**	**1**	**1**

ARUP

Project Number: 271565

Phone: 1 212 896 3000

Remove page Remove page

LASER BLADE ORIGINAL

DOWNLIGHT - NEW CONSTRUCTION WITH PLASTER FRAME - REMOTE

Type:

Project :

SPECIFICATION SHEET

Page: 4 of 7

Type:

AL08

Page 4 of 7

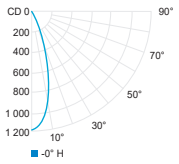
PHOTOMETRIC DATA

ILB02

CCT (K)*	CRI	LOAD (W)	OPTIC	LUMENS (lm)	EFFICACY (lm / w)	MAX CANDELA (cd)	MODELS
3000K	90	6.5W	Flood 32°	330	50	1 110	ILB02-930-FL

*USE MULTIPLIER TABLE FOR OTHER CCT AND CRI OUTPUT DATA

Flood 32° (3000K, 90 CRI)



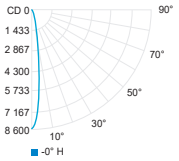
	Center beam fc	Beam width ft
2ft	278	1.1
4ft	69.6	2.3
6ft	30.9	3.4
8ft	17.4	4.5
10ft	11.1	5.7
12ft	7.73	6.8

ILB05

CCT (K)*	CRI	LOAD (W)	OPTIC	LUMENS (lm)	EFFICACY (lm / w)	MAX CANDELA (cd)	MODELS
3000K	90	13W	Spot 12°	785	60	8 555	ILB05-930-SP
			Flood 32°	795	60	2 740	ILB05-930-FL
			Wide flood 48°	825	63	1 465	ILB05-930-WF
			General light pro	715	55	985	ILB05-930-GP

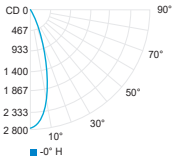
*USE MULTIPLIER TABLE FOR OTHER CCT AND CRI OUTPUT DATA

Spot 12° (3000K, 90 CRI)



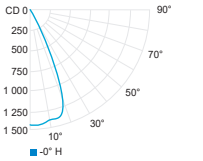
	Center beam fc	Beam width ft
2ft	2 139	0.4
4ft	535	0.9
6ft	238	1.3
8ft	134	1.8
10ft	85.6	2.2
12ft	59.4	2.7

Flood 32° (3000K, 90 CRI)



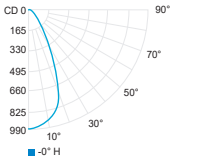
	Center beam fc	Beam width ft
2ft	685	1.1
4ft	171	2.2
6ft	76.1	3.4
8ft	42.8	4.5
10ft	27.4	5.6
12ft	19.0	6.7

Wide flood 48° (3000K, 90 CRI)



	Center beam fc	Beam width ft
2ft	366	1.8
4ft	91.6	3.5
6ft	40.7	5.3
8ft	22.9	7.0
10ft	14.7	8.8
12ft	10.2	10.6

General light pro (3000K, 90 CRI)



	Center beam fc	Beam width ft
2ft	247	1.8
4ft	61.8	3.6
6ft	27.5	5.4
8ft	15.4	7.3
10ft	9.89	9.1
12ft	6.86	10.9

CCT options	2700K	3000K	3500K	4000K	3000K
CRI options	95CRI	95CRI	95CRI	95CRI	90CRI
Multiplier	**0.85**	**0.92**	**1**	**1**	**1**

JP - R22 Last update: October 29, 2020

Due to continuous improvements, the information herein may be changed without notice

iGuzzini NORTH AMERICA

9320 Boul. St-Laurent, suite 100, Montréal (Québec) Canada H2N 1N7, P.: 514.523.1339 F.: 514.525.6107 www.iguzzini.com/us

ARUP

Project Number: 271565

Phone: 1 212 896 3000

Remove page

Remove page

LASER BLADE ORIGINAL

DOWNLIGHT - NEW CONSTRUCTION WITH PLASTER FRAME - REMOTE

Type:

Project :

SPECIFICATION SHEET

Page: 5 of 7

Type:

AL08

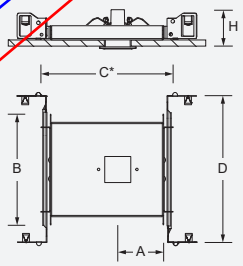
Page 5 of 7

INSTALLATION

New construction with plaster frame (NC)

Plaster frame with hanger bars system to be installed during rough-in phase. Suitable for insulated or non-insulated ceiling assemblies, like sheetrock, or paneling. Plaster frame and trim can be shipped separately.
(Power supply is not accessible from luminaire opening)

Ceiling thickness:
Trim: ⅛" to 1⅛" (3mm to 29mm)
Trimless: ⅝" (16mm)



*Provide a minimum of 1⅞" (46mm) on each side for the hanger bar fixations

Model	Plaster frame	Cut-out dimensions	Cut-out position (A)	Overall dimensions (BxC)	Hanger bars (D)	Clearance (H)
ILB01	BN-LB01TR-NC	1⅜" x 1⅜" (35 x 35mm)	6⅞" (174mm)	5⅞" x 7" (149 x 178mm)	9" to 15¼" (229 to 387mm)	2½" (64mm)
	BN-LB01TL-NC					
ILB02	BN-LB02TR-NC	1⅜" x 2½" (35 x 64mm)	6⅜" (160mm)			
	BN-LB02TL-NC					
ILB05	BN-LB05TR-NC	1½" x 5⅝" (37 x 141mm)	5¼" (133mm)	5⅞" x 11" (149 x 279mm)		
	BN-ILB05TL-NC	1⅜" x 5⅝" (35 x 141mm)				

iGuzzini NORTH AMERICA

9320 Boul. St-Laurent, suite 100, Montréal (Québec) Canada H2N 1N7, P.: 514.523.1339 F.: 514.525.6107 www.iguzzini.com/us

ARUP

Project Number: 271565
Phone: 1 212 896 3000

Remove page

Remove page

LASER BLADE ORIGINAL

DOWNLIGHT - NEW CONSTRUCTION WITH PLASTER FRAME - REMOTE

Type:

Project :

SPECIFICATION SHEET

Page: 6 of 7

Type:

AL08

Page 6 of 7

ORDERING INFO

ILB05 - TR - NC - 030 - WF - REM - 10
FIXTURE

BN - LB 05 TR - NC
HOUSING

MODEL

☐ **01 -** Single ☐ **02 -** Double ■ **05 -** Five

MOUNTING

■ **TR -** Trim ☐ **TL -** Trimless

INSTALLATION TYPE

■ **NC -** New construction

LED

☐ **027 -** 2700K, 95CRI ■ **030 -** 3000K, 95CRI ☐ **035 -** 3500K, 95CRI ☐ **040 -** 4000K, 95CRI ☐ **930 -** 3000K, 90CRI

OPTIC

☐ **SP -** Spot 12°(1) ☐ **FL -** Flood 32° ■ **WF -** Wide flood 48°(1) ☐ **GP -** General light pro(1)

VOLTAGE

■ **REM -** with remote power supply ☐ **POE -** Power over ethernet. (consult customer service)

FINISH (trim finish / baffle finish*)

	White trim	Gray trim	Black t rim	Trimless
■ **Black baffle**	☐ **01 -** White/Black	■ **10 -** Gray/Black	☐ **02 -** Black/Black	☐ **02 -** Black
☐ **White baffle**	☐ **31 -** White/White			☐ **31 -** White

(1) Available for the five (**05**) model.
*Custom baffle finish available, contact customer service for details.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page Remove page

LASER BLADE ORIGINAL

DOWNLIGHT - NEW CONSTRUCTION WITH PLASTER FRAME - REMOTE

Type:
Project :

SPECIFICATION SHEET
Page 7 of 7

Type:

AL08

Page 7 of 7

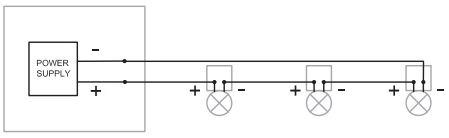
REMOTE LED DRIVER OPTIONS
(TO BE ORDERED SEPARATELY)

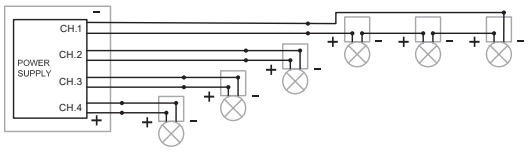
							ILB01 2.1W*	ILB02 4.2W*	ILB05 10.5W*
Watts	Voltage	Rated	Dimming protocol	Dimming range	Dimensions	Max distance**	Min-max units		
■	4444-0700-011-UNV-ND								
11	120-277V	Indoor	None	None	6" x 4" x 3" (152 x 102 x 76mm)	30ft(9m)	3-4	2	
☐	4450-0700-012-120-LTE								
12	120V	Indoor	Leading and trailing edge (ELV and TRIAC)	Down to ±15%	8" x 8" x 4" (203 x 203 x 102mm)	30ft(9m)	2-5	1-2	1
☐	4443-0700-014-UNV-D2								
14	120-277V	Indoor	Lutron Hi Lume® 1% EcoSystem™ (Soft-on, Fade to Black)	Down to ±1%	5" x 4" x 3" (127 x 102 x 76mm)	30ft(9m)	5-6	3	1
☐	4443-0700-014-120-D3								
14	120V	Indoor	Lutron Hi Lume® 1% 2-wire (120V forward phase only)	Down to ±1%	5" x 4" x 3" (127 x 102 x 76mm)	30ft(9m)	3-6	2-3	1
☐	4444-0700-022-120-LTE								
22	120V	Indoor	Leading and trailing edge (ELV and TRIAC)	Down to ±15%	6" x 4" x 3" (152 x 102 x 76mm)	30ft(9m)	4-9	2-4	1-2
☐	4443-0700-025-UNV-D2								
25	120-277V	Indoor	Lutron Hi Lume® 1% EcoSystem™ (Soft-on, Fade to Black)	Down to ±1%	5" x 4" x 3" (127 x 102 x 76mm)	30ft(9m)	8-11	4-5	2
☐	4443-0700-026-120-D3								
26	120V	Indoor	Lutron Hi Lume® 1% 2-wire (120V forward phase only)	Down to ±1%	5" x 4" x 3" (127 x 102 x 76mm)	30ft(9m)	6-11	3-5	2
☐	4450-0700-030-UNV-SD10								
30	120-277V	Indoor	0-10V ELDOLED SOLOdrive	Down to ±0.1%	8" x 8" x 4" (203 x 203 x 102mm)	118ft(36m)	1-13	1-6	1-2
☐	4443-0700-035-UNV-D2								
35	120-277V	Indoor	Lutron Hi Lume® 1% EcoSystem™ (Soft-on, Fade to Black)	Down to ±1%	5" x 4" x 3" (127 x 102 x 76mm)	30ft(9m)	11-15	6-7	3
☐	4443-0700-037-120-D3								
37	120V	Indoor	Lutron Hi Lume® 1% 2-wire (120V forward phase only)	Down to ±1%	5" x 4" x 3" (127 x 102 x 76mm)	30ft(9m)	11-16	6-8	3
☐	4445-0700-040-120-LTE								
40	120V	Indoor	Leading and trailing edge (ELV and TRIAC)	Down to ±15%	6" x 6" x 3" (152 x 152 x 76mm)	30ft(9m)	13-16	6-8	3
☐	4450-0700-038-UNV-ED10								
38	120-277V	Indoor	0-10V ELDOLED ECOdrive	Down to ±1%	8" x 8" x 4" (203 x 203 x 102mm)	118ft(36m)	1-16	1-8	1-3
☐	4448-0700-100-UNV-SD10 (4 channels)								
100	120-277V	Indoor	0-10V ELDOLED SOLOdrive	Down to ±0.1%	10" x 8" x 4" (254 x 203 x 102mm)	118ft(36m)	1-44 11/channel	1-20 5/channel	1-8 2/channel

* Wattage requirement for one (1) fixture (Remote fixture only).
** Calculated for 16AWG cable. Contact customer service for longer remote distance.

WIRING DIAGRAMS

*Multiple luminaires must be connected in series (home run or fixture chain)





JP - R22 Last update: October 29, 2020

Due to continuous improvements, the information herein may be changed without notice

iGuzzini NORTH AMERICA

9320 Boul. St-Laurent, suite 100, Montréal (Québec) Canada H2N 1N7, P.: 514.523.1339 F.: 514.525.6107 www.iguzzini.com/us

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page Remove page

Manufacturer: iGuzzini : Laser Blade
Description: Recessed Linear Fixture Outdoor Rated

Fixture Wattage: 4 W
Lumen Output: 614 lumen
Lamp CRI: 80+
Lighting Controls: 0-10V Dimming

Voltage: 120 V
Fixture Finish: Silver
Lamp CCT: 3000K
Assembly Code: I.LBX60 REM XX

LASER BLADE 5 REMOTE

InOut

SPECIFICATION SHEET PAGE: 1 OF 5
Project name:
Type:

Low luminance architectural downlight for inside or outside application.

Luminaire characteristics:
Power input: 10W
Lumens: 580 to 695lm
Luminaire efficacy: 58 to 69 lm/W

Source: White LED, (LM-80 tested),
2700K : 95CRI,
3000K : 90CRI,
4000K : 95 CRI.
Lumen maintenance: 80% of initial lumens at 50 000 hours (L80) LM-79 tested.

Optic: Available with low luminance Wide flood or Spot optics, with Optibeam technology

Mounting: New construction plaster frame or insulated ceiling.

Material:
Body and heat-sink: Die-cast aluminum
Frame: Aluminum alloy
Reflector: Thermoplastic
Baffles: Thermoplastic
Hardware: Stainless steel

Electrical: See remote power supply options on page 5.

Finish: Gray (RAL9006) or White (RAL9010) painted finish.

Weight: 1.76lbs. (0.80kg).

Warranty: 5 year limited warranty.

Certification: cULus listed for wet location.

Ratings: IP65, IK06.

DUE TO CONTINUOUS IMPROVEMENTS, THE INFORMATION HEREIN MAY BE CHANGED WITHOUT NOTICE.

LAST UPDATE: JANUARY 25, 2018 LP - R2

iGuzzini NORTH AMERICA

PRELIMINARY DATA
JANUARY, 2018

c UL us

9320 Boul. St-Laurent, suite 100, Montréal (Québec)Canada H2N 1N7
P.: 514.523.1339 F.: 514.525.6107 www.iguzzini-na.com

Type:

AL09

Page 1 of 5

Lighting Notes:

1. Contractor to coordinate remote driver quantities in accordance with manufacturer recommendations.
2. Contractor to coordinate remote driver locations in nearest possible location with architect.
3. Fixture finish to be confirmed by architect.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page Remove page

LASER BLADE 5 REMOTE

InOut

SPECIFICATION SHEET PAGE: 2 OF 5

Project name:

Type:

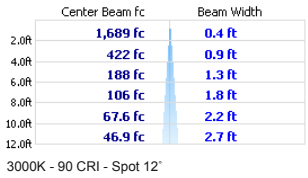
Type:

AL09

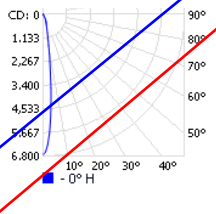
Page 2 of 5

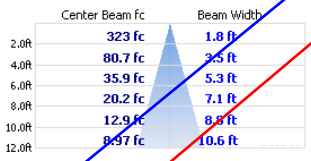
TECHNICAL DATA

LOAD (W)	CCT (K)	CRI	OPTIC	LUMENS (lm)	EFFICACY (lm / w)	MAX CANDELA (cd)	MODELS
10W	4000K	95	WIDE FLOOD	695	69	1290	I.BX58
	3000K	90	SPOT	630	63	6755	I.BX59
			WIDE FLOOD	695	69	1290	I.BX60
	2700K	95	SPOT	580	58	6240	I.BX61
			WIDE FLOOD	645	64	1190	I.BX62

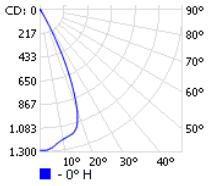


3000K - 90 CRI - Spot 12˚





3000K - 90 CRI - Wide flood 48˚



DUE TO CONTINUOUS IMPROVEMENTS, THE INFORMATION HEREIN MAY BE CHANGED WITHOUT NOTICE.

LAST UPDATE: JANUARY 25, 2018 LP - R2

iGuzzini NORTH AMERICA

9320 Boul. St-Laurent, suite 100, Montréal (Québec)Canada H2N 1N7
P.: 514.523.1339 F.: 514.525.6107 www.iguzzini-na.com

PRELIMINARY DATA
JANUARY, 2018

ARUP
Project Number: 271565
Phone: 1 212 896 3000

LASER BLADE 5 REMOTE

InOut

SPECIFICATION SHEET PAGE: 2 OF 5

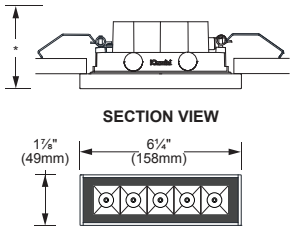
Project name:

Type:

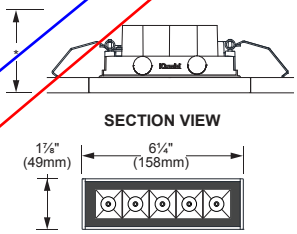
Type:

AL09

Trim



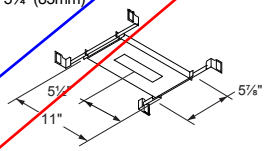
Flush Mount



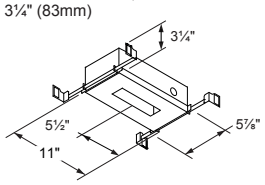
HOUSINGS

Trim version:
Hanger bars: 9" to 15¼" (229mm x 387mm)
with extentions: 15" to 24" (381mm x 610mm)

BN5103 - New construction plaster frame suitable for insulated ceilings.
Dimensions: 5⅞" x 11" (149mm x 279mm)
Clearance: 3¼" (83mm)



BI5113 - New construction housing suitable for insulated ceilings.
Dimensions: 5⅞" x 11" x 3¼" (149mm x 279mm x 83mm)
Clearance: 3¼" (83mm)



INSTALLATION INFO

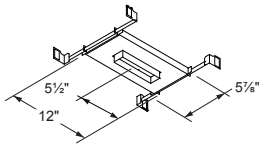
Ceiling thickness:
Dimensions: Min: ⅛" (3mm), Max 1" (25mm)

Cut-out dimensions:
Dimensions: 1½" x 5½" (37mm x 141mm)

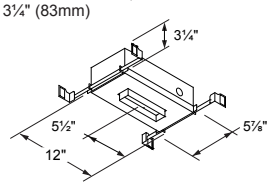
HOUSINGS

Trim version:
Hanger bars: 9" to 15¼" (229mm x 387mm)
with extentions: 15" to 24" (381mm x 610mm)

BN5145 - New construction plaster frame suitable for insulated ceilings.
Dimensions: 5⅞" x 12" (149mm x 305mm)
Clearance: 3¼" (83mm)



BI5145 - New construction housing suitable for insulated ceilings.
Dimensions: 5⅞" x 12" x 3¼" (149mm x 305mm x 83mm)
Clearance: 3¼" (83mm)



INSTALLATION INFO FLUSH MOUNT

Ceiling thickness:
Dimension: ⅝" (15mm)

Cut-out dimensions:
Dimensions: 2¼" x 6½" (56mm x 164mm)

DUE TO CONTINUOUS IMPROVEMENTS, THE INFORMATION HEREIN MAY BE CHANGED WITHOUT NOTICE.

LAST UPDATE: JANUARY 25, 2018 LP - R2

iGuzzini NORTH AMERICA

9320 Boul. St-Laurent, suite 100, Montréal (Québec)Canada H2N 1N7
P.: 514.523.1339 F.: 514.525.6107 www.iguzzini-na.com

PRELIMINARY DATA
JANUARY, 2018

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page

Remove page

LASER BLADE 5 REMOTE

InOut

SPECIFICATION SHEET PAGE: 4 OF 5

Project name:

Type:

Type:

AL09

ORDERING INFO

RESET

I.BX60 - REM -

MODEL | VOLTAGE | FINISH | MOUNTING

MODEL

- ○ **I.BX58 -** 4000K, 95CRI
- ○ **I.BX59 -** 3000K, 90CRI
- ● **I.BX60 -** 3000K, 90CRI
- ○ **I.BX61 -** 2700K, 95CRI
- ○ **I.BX62 -** 2700K, 95CRI

VOLTAGE

- ● **REM -** Remote

FINISH

- ○ **01 -** White/Black
- ○ **10 -** Gray/Black

MOUNTING

Trim

- ○ **BN5103 -** New construction plaster frame
- ○ **BI5113 -** New construction housing

Flush mount

- ○ **BN5145 -** New construction plaster frame
- ○ **BI5145 -** New construction housing

DUE TO CONTINUOUS IMPROVEMENTS, THE INFORMATION HEREIN MAY BE CHANGED WITHOUT NOTICE.

LAST UPDATE: JANUARY 25, 2018 LP - R2

iGuzzini NORTH AMERICA

PRELIMINARY DATA
JANUARY, 2018

c UL us

9320 Boul. St-Laurent, suite 100, Montréal (Québec)Canada H2N 1N7
P.: 514.523.1339 F.: 514.525.6107 www.iguzzini-na.com

ARUP

Project Number: 271565
Phone: 1 212 896 3000

Remove page Remove page

LASER BLADE 5 REMOTE

InOut

SPECIFICATION SHEET PAGE: 5 OF 5

Project name:

Type:

Type: AL09

Page 5 of 5

ORDERING INFO RESET

REMOTE POWER SUPPLY OPTION

Requirement for one (1) fixture: 700mA, 15V

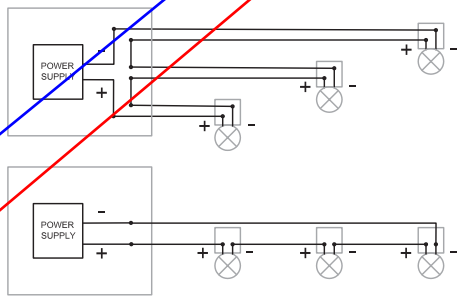
- ◯ **4444-0700-011-UNV-ND**
- ◯ **4444-0700-025-UNV-D10**
- ◯ **4444-0700-012-120-LTE**
- ◯ **4450-0700-014-UNV-D2**
- ◯ **4450-0700-030-UNV-ED10**
- ◯ **4450-0700-050-UNV-ED10**
- ◯ **4450-0700-030-UNV-SD10**
- ◯ **4450-0700-050-UNV-SD10**
- ◯ **4448-0700-100-UNV-SD10**

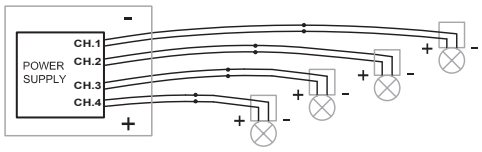
REMOTE POWER SUPPLY OPTION
(TO BE ORDERED SEPARATELY)

Watts	Min-Max	Voltage	Dimming Range	Dimming protocol	Box dimensions	Max distance at full load (16AWG)	Code
11	1	120-277V	—	None	6" X 4" X 3" (152 X 102 X 76mm)	30ft (9m)	4444-0700-011-UNV-ND
25	1-2	120-277V	Down to ±15%	0-10V	6" X 4" X 3" (152 X 102 X 76mm)	30ft (9m)	4444-0700-025-UNV-D10
12	1	120V	Down to ±15%	Leading and trailing edge (ELV and TRIAC)	6" X 4" X 3" (152 X 102 X 76mm)	30ft (9m)	4444-0700-012-120-LTE
14	1	120-277V	Down to ±5%	Lutron Hi Lume® A-Series (3 wires or EcoSystem®)	8" x 8" x 4" (203x 203 x 102mm)	35ft (10m)	4450-0700-014-UNV-D2
30	1-2	120-277V	Down to ±1%	0-10V ELDOLED ECOdrive	8" x 8" x 4" (203x 203 x 102mm)	118ft (36m)	4450-0700-030-UNV-ED10
50	1-3	120-277V	Down to ±1%	0-10V ELDOLED ECOdrive	8" x 8" x 4" (203x 203 x 102mm)	118ft (36m)	4450-0700-050-UNV-ED10
30	1-2	120-277V	Down to ±0.1%	0-10V ELDOLED SOLOdrive	8" x 8" x 4" (203x 203 x 102mm)	118ft (36m)	4450-0700-030-UNV-SD10
50	1-4 2 channels	120-277V	Down to ±0.1%	0-10V ELDOLED SOLOdrive	8" x 8" x 4" (203x 203 x 102mm)	118ft (36m)	4450-0700-050-UNV-SD10
100	1-8 4 channels	120-277V	Down to ±0.1%	0-10V ELDOLED SOLOdrive	10" x 8" x 4" (254x 203 x 102mm)	118ft (36m)	4448-0700-100-UNV-SD10

WIRING DIAGRAMS

*Multiple luminaires must be connected in series (home run or fixture chain)





DUE TO CONTINUOUS IMPROVEMENTS, THE INFORMATION HEREIN MAY BE CHANGED WITHOUT NOTICE.

LAST UPDATE: JANUARY 25, 2018

LP - R2

iGuzzini NORTH AMERICA

PRELIMINARY DATA
JANUARY, 2018

c UL us

9320 Boul. St-Laurent, suite 100, Montréal (Québec)Canada H2N 1N7
P.: 514.523.1339 F.: 514.525.6107 www.iguzzini-na.com

ARUP

Project Number: 271565

Phone: 1 212 896 3000

Remove page Remove page

Manufacturer: BEGA : 22248
Description: Recessed Wall Light

Fixture Wattage: 3.9 W
Lumen Output: 159 lumen
Lamp CRI: 80+
Lighting Controls: 0-10V Dimming

Voltage: 120 V
Fixture Finish: Dark Grey
Lamp CCT: 2700K
Assembly Code: 22248-K3

LED recessed wall - shielded

BEGA

Type: AW02

Application
Designed for low mounting heights for interior and exterior locations, the shielded light distribution is ideal for the glare-free illumination of ground surfaces, building entrances, stairs, and footpaths.

Materials
Luminaire housing and faceplate constructed of die-cast marine grade, copper free (≤ 0.3% copper content) A360.0 aluminum alloy
White safety glass
High temperature silicone gasket
Mechanically captive stainless steel fasteners

NRTL listed to North American Standards, suitable for wet locations
Protection class IP 65
Weight: 2.2 lbs

Electrical

Operating voltage	120-277V AC
Minimum start temperature	-30° C
LED module wattage	3.9 W
System wattage	6.0 W
Controllability	0-10V dimmable
Color rendering index	Ra > 90
Luminaire lumens	159 lumens (3000K)
Lifetime at Ta = 15° C	>500,000 h (L70)
Lifetime at Ta = 45° C	172,000 h (L70)

LED color temperature

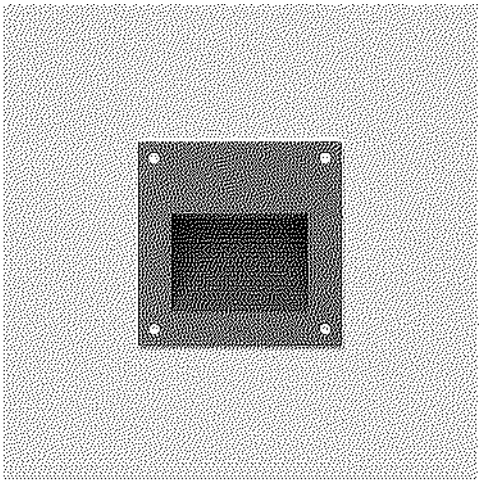
☐ 4000K - Product number + **K4**
☐ 3500K - Product number + **K35**
☒ 3000K - Product number + **K3 (*EXPRESS*)**
☐ 2700K - Product number + **K27**
☐ Amber - Product number + **AMB**

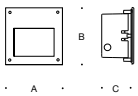
BEGA can supply you with suitable LED replacement modules for up to 20 years after the purchase of LED luminaires - see website for details

Finish
All BEGA standard finishes are matte, textured polyester powder coat with minimum 3 mil thickness.

Available colors ☐ Black (BLK) ☐ White (WHT) ☒ RAL:
☐ Bronze (BRZ) ☐ Silver (SLV) ☐ CUS:

Type:
BEGA Product:
Project:
Modified:





LED recessed wall · shielded

		LED	A	B	C
22272	ADA	3.9 W	5 7/8	5 7/8	4 1/8

BEGA 1000 BEGA Way, Carpinteria, CA 93013 (805) 684-0533 info@bega-us.com

Due to the dynamic nature of lighting products and the associated technologies, luminaire data on this sheet is subject to change at the discretion of BEGA North America. For the most current technical data, please refer to bega-us.com
© copyright BEGA 2018

Updated 12/13/19

Lighting Notes:

1. Fixture finish to be confirmed by architect.
2. Coordinate mounting height above grade with architectural drawings. Fixture to be at least 3ft AFFL to avoid being covered in snow during winter.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page

Remove page

Type:

Admin Building

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Manufacturer: iGuzzini : Palco In Out
Description: Surface Mounted Spotlight (Low Voltage)

Fixture Wattage:	9 W	**Voltage:**	24 V
Lumen Output:	653 lumen	**Fixture Finish:**	Grey
Lamp CRI:	80+	**Lamp CCT:**	2700K
Lighting Controls:	0-10V Dimming	**Assembly Code:**	EH97

Palco InOut

Design Artec3 Studio iGuzzini

Last information update: October 2020

Product configuration: EH97
EH97: Spotlight with base - Warm White Led - integrated electronic control gear - Very Wide Flood optic

Product code
EH97: Spotlight with base - Warm White Led - integrated electronic control gear - Very Wide Flood optic

Technical description
Spotlight designed to use LED lamps and a Very Wide Flood optic. The optical assembly and base is made of EN1706AC 46100LF aluminium alloy and subjected to a multi-step, pre-treatment process, in which the main phases are degreasing, fluorozirconation (a protective surface film) and sealing (with a nano-structured silane layer). The following painting stage consists of a primer and a liquid acrylic paint, cured at 150°C, with a high level of weather and UV ray resistance. 5 mm thick tempered sodium-calcium closing glass. Double adjustability allows a 360° rotation about the vertical axis and 90° tilting relative to the horizontal plane. Mechanical aiming locks for rotation on both the vertical axis and horizontal plane. Complete with a monochrome LED circuit and an Opti Beam Reflector optic system. The product includes a PG13.5 cable gland. Electronic On/Off ballast integrated in product. Option of using optic accessories assembled via an accessory holder frame. All external screws used are made of A2 stainless steel.

Installation
Floor, wall, ceiling or ground-installed via pole or stake.

Colour
White (01) | Grey (15)

Weight (Kg)
1.9

Mounting
wall surface|ground spike

Wiring
Double PG.

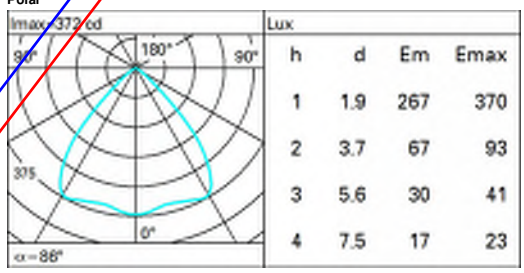
Complies with EN60598-1 and pertinent regulations

IK07 IP66

Technical data

lm system:	653	Life Time LED 1:	65,000h - L80 - B10 (Ta 25°C)
W system:	10.9	Life Time LED 2:	65,000h - L80 - B10 (Ta 40°C)
lm source:	920	Ballast losses [W]:	1.8
W source:	9.1	Lamp code:	LED
Luminous efficiency (lm/W, real value):	59.9	Number of lamps for optical assembly:	1
lm in emergency mode:	-	ZVEI Code:	LED
Total light flux at or above an angle of 90° [Lm]:	0	Number of optical assemblies:	1
Light Output Ratio (L.O.R.) [%]:	71	Ambient operating temperature range:	from -20°C to 50°C.
Beam angle [°]:	86°	Lifetime of product at ambient operating temperature:	≥ 50.000h Ta=40°C
CRI:	80	Power factor:	See installation instructions
Colour temperature [K]:	3000	Overvoltage protection:	2kV Common mode & 1kV Differential mode
MacAdam Step:	2	Control:	On/off

Polar



EH97_EN 1 / 2

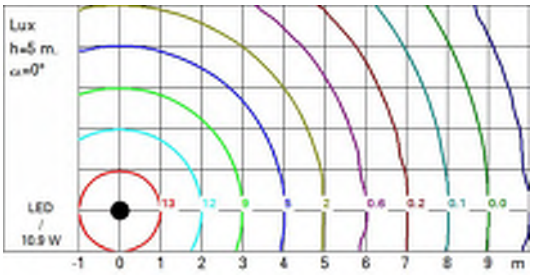
Type:
AWS02

Lighting Notes:

1. Finish to be confirmed by architect.
2. Contractor to coordinate mounting with Architect.
3. Contractor to coordinate with Architect and Lighting Consultant for final aiming and focus for adjustable fixtures.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Isolux



UGR diagram

Corrected UGR values (at 920 lm bare lamp luminous flux)

Reflect.: ceil/cav		0.70	0.70	0.50	0.50	0.30	0.70	0.70	0.50	0.50	0.30
walls		0.50	0.30	0.50	0.30	0.30	0.50	0.30	0.50	0.30	0.30
work pl.		0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Room dim.				viewed crosswise					viewed endwise		
x	y										
2H	2H	23.9	24.7	24.2	24.9	25.1	23.9	24.7	24.2	24.9	25.1
	3H	23.8	24.5	24.1	24.7	25.0	23.8	24.5	24.1	24.7	25.0
	4H	23.7	24.3	24.1	24.6	24.9	23.7	24.4	24.1	24.8	25.0
	6H	23.6	24.2	24.0	24.5	24.9	23.7	24.2	24.0	24.5	24.9
	8H	23.6	24.1	24.0	24.5	24.8	23.8	24.2	24.0	24.5	24.8
	12H	23.6	24.1	23.9	24.4	24.8	23.8	24.1	24.0	24.4	24.8
4H	2H	23.7	24.4	24.1	24.6	25.0	23.7	24.3	24.1	24.8	24.9
	3H	23.6	24.1	24.0	24.5	24.8	23.8	24.1	24.0	24.5	24.8
	4H	23.5	24.0	23.9	24.3	24.7	23.5	24.0	23.9	24.3	24.7
	6H	23.4	23.8	23.9	24.2	24.7	23.4	23.8	23.9	24.2	24.7
	8H	23.4	23.8	23.8	24.2	24.6	23.4	23.8	23.8	24.2	24.6
	12H	23.3	23.7	23.8	24.1	24.6	23.3	23.7	23.8	24.1	24.6
6H	4H	23.4	23.8	23.8	24.2	24.6	23.4	23.8	23.8	24.2	24.6
	6H	23.3	23.6	23.8	24.0	24.5	23.3	23.6	23.8	24.0	24.5
	8H	23.3	23.5	23.7	24.0	24.5	23.3	23.5	23.7	24.0	24.5
	12H	23.2	23.4	23.7	23.9	24.4	23.2	23.4	23.7	23.9	24.4
12H	4H	23.3	23.7	23.8	24.1	24.6	23.3	23.7	23.8	24.1	24.6
	6H	23.3	23.5	23.7	24.0	24.5	23.3	23.5	23.7	24.0	24.5
	8H	23.2	23.4	23.7	23.9	24.4	23.2	23.4	23.7	23.9	24.4

Variations with the observer position at spacing:

S =			
	1.0H	2.7 / -7.1	2.7 / -7.1
	1.5H	4.6 / -11.5	4.6 / -11.5
	2.0H	6.6 / -13.9	6.6 / -13.9

Type:

AWS02

ARUP
Project Number: 271565
Phone: 1 212 896 3000

EH97_EN 2 / 2

Manufacturer: USAI Lighting : 4.5” Round Deep Regress Downlight
Description: Recessed Downlight

Fixture Wattage: 33 W
Lumen Output: 1925 lumen
Lamp CRI: 80+
Lighting Controls: 0-10V Dimming

Voltage: 120 V
Fixture Finish: White
Lamp CCT: 3000K
Assembly Code: B4RCF-33C3-30KH-70-S-WH-WH-NC-UNV-D6E

BeveLED® 2.2 Complete
4.5” Round Deep Regress Downlight - B4RC

USAI® Lighting

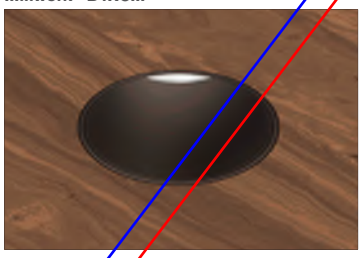
Type: AD02

Universal and Field Convertible - Trim | Trimless | Millwork

Trimmed - B4RCF

Trimless - B4RCL

Millwork - B4RCM



usailighting.com/beveled

FEATURES

- Field Flexibility between trimmed, trimless and millwork
- Dry/damp/wet location rated for bathrooms and showers, including trimless and millwork
- 1% dimming standard + more dimming options
- Clear overspray protector for installation convenience
- Full family platform
- Iconic beveled look

COMPANION FAMILY PRODUCTS

Downlight - B4RD
usailighting.com/B4RD

Adjustable - B4RA
usailighting.com/B4RA

Wall Wash - B4RW
usailighting.com/B4RW

DEEP REGRESS DOWNLIGHT PERFORMANCE DATA

LED COLOR CHOICES

DELIVERED* PERFORMANCE:	Classic White						Warm Glow Dimming		Color Select	
	9W	12W	16W	24W	33W	36W	16W	32W	16W	32W
Source Lumens:	1150	1300	1725	2400	3025	4150	1275	2150	1250	2075
Lumens Per Watt:	70	69	68	64	58	85	56	47	54	52
Delivered Lumens:	625	825	1100	1550	1925	2950	900	1500	850	1525
EM Mode Output:	450 Delivered Lumens (nominal)						350 Delivered Lumens		375 Delivered Lumens	

*Based on 3000K, 80+ CRI. Performance varies for each specific beamspread and color temperature. See IES files for exact values at usailighting.com.

CORRELATED COLOR TEMPERATURE MULTIPLIER	Classic White									Warm Glow Dimming					Color Select					
	2200K	2700K		3000K		3500K		4000K		2700K		3000K		3500K	2200K	2700K	3500K	4000K	5000K	6000K
Color Rendering Index:	80+	80+	90+	80+	90+	80+	90+	80+	90+	80+	90+	80+	90+	80+	80+	80+	80+	80+	80+	80+
Multiplier for Lumen Output:	0.72	0.94	0.78	1.00	0.78	1.00	1.00	1.06	1.06	0.94	0.74	1.00	0.80	1.07	0.87	0.96	1.04	1.09	1.13	1.18

THE COMPLETE BEVELED FAMILY PLATFORM

More Ceiling Applications | More Sizes and Shapes | Armstrong® Ceiling Solutions Compatible

Sloped Ceiling | BeveLED Block | Cylinders | BeveLED Micro | BeveLED Mini | BeveLED 5.0 | Trimless Acoustical | Connect TechZone | BeveLED Connect

USAI LIGHTING COLLABORATORY
13 Crosby Street
New York, NY 10013
845-234-4090
showroom@usailighting.com

USAI LIGHTING HEADQUARTERS
1126 River Road
New Windsor, NY 12553
T: 845-565-8500
info@usailighting.com

© 2018. USAI, LLC. All rights reserved.
All designs protected by copyright. Covered by US Patents: 8,581,520, 8,456,109, 8,742,695, 9,671,091 and 7,832,889. Patents pending. USAI, BeveLED, Warm Glow Dimming and Color Select are registered trademarks of USAI, LLC.
Revised 06/04/2019

Lighting Notes:

1. Contractor to coordinate remote driver quantities in accordance with manufacturer recommendations.
2. Contractor to coordinate remote driver locations in nearest possible location with architect.
3. Fixture finish to be confirmed by architect.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

HOW TO SPECIFY

BeveLED® 2.2 Complete
4.5″ Round Deep Regress Downlight - B4RC

USAI® Lighting

Type: AD02

Specify fixture part number. (All boxes must be filled in to correctly order)

B4RC__

BeveLED Trim Style

F Trimmed with Flange (use with all materials)

L Trimless Spackle-in (use with sheetrock and plaster only)

M Millwork Knife-Edge (use with wood and stone)

Wattage Options

Classic White Light

09C3 9W LED
12C3 12W LED
16C3 16W LED
24C3 24W LED
33C3 33W LED
36E1 36W LED

Warm Glow Dimming

16WG2 16W LED
32WG2 32W LED

Color Select Tunable White

16CS1 16W LED
32CS1 32W LED

LED Color Options

Classic White Light

22KS (1) 2200K, 80+ CRI
27KS 2700K, 80+ CRI
27KH 2700K, 90+ CRI
30KS 3000K, 80+ CRI
30KH 3000K, 90+ CRI
35KS 3500K, 80+ CRI
35KH 3500K, 90+ CRI
40KS 4000K, 80+ CRI
40KH 4000K, 90+ CRI

Warm Glow Dimming

2722KS 2700K-2200K, 80+ CRI
2722KH 2700K-2200K, 90+ CRI
3022KS 3000K-2200K, 80+ CRI
3022KH 3000K-2200K, 90+ CRI
3522KS 3500K-2200K, 80+ CRI

Color Select Tunable White

6022KS 6000K-2200K, Tunable White Light 80+ CRI

Beam Options

Classic White Light

25 25° beam
40 40° beam
70 70° beam

Warm Glow Dimming

25 25° beam
40 40° beam
65 65° beam

Color Select Tunable White

30 30° beam
40 40° beam
50 50° beam

Lens Options

S Solite (provided standard)
SF Solite Frosted
BF Borosilicate Frosted

Bevel Trim Finish Options

WH White
SC Conduit Silver
GR Grey
BL Black
BZ Bronze
PR Primer Finish
AC Clear Matte Anodized
AB Piano Gloss Black
RAL Custom Color Specify RAL #

*Flange/ Millwork Collar Finish

WH White
SC Conduit Silver
GR Grey
BL Black
BZ Bronze
PR Primer Finish
AC Clear Matte Anodized
WH White
GR Grey
BL Black
AB Piano Gloss Black
WH White
GR Grey
BL Black
RAL Custom Color Specify RAL #

*Leave blank for Trimless

Housing Options

NCSM New Construction Narrow Width
NC New Construction
NCCP Chicago Plenum
NCIC Insulation Contact Rated / Airtight (1)

Voltage Options *Select one*

UNV 120V-277V
120V
347V

Dimming Driver Options

For use with Universal Voltage 120V - 277V

No Additional Charge
D6E EldoLED 0-10V, 1% (provided standard)
D6F EldoLED 0-10V, 1%

D4A Lutron Hilume Premier ECO, 0.1% (1, 2, 3, 5, 6)
D4E Lutron 5 ECO, 5% (2, 3, 4)
D4H Lutron H ECO, 1% Fade (2, 3, 4)
D4P Lutron Hilume Premier ECO, 1% (1, 5, 6)
D6A EldoLED 0-10V, 0.1%
D6B EldoLED 0-10V, 0.1%
D7 EldoLED DALI, 0.1%
D18 Moons DMX, 0.1% (2, 3)

For use with 120V only

No Additional Charge
D19 Phase 2-wire, 1% (1, 2, 3, 4, 5)
D3 Lutron 2-wire, 1%

For use with 347V only

D15 0-10V dim, 1% 347V only (2, 3)

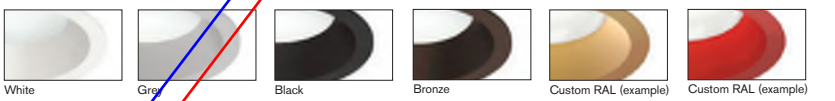
Accessories (Optional)*

CB27 27" C-Channel Bars
CB32 32" C-Channel Bars
CB52 52" C-Channel Bars
EM Emergency Battery (7)
EMW Emergency Battery Wet Location (7)

*Residential grade nailer bars provided standard

Notes: *1 Not available with 36E1LED 2 Not available for Warm Glow. 3 Not available for Color Select. 4 Not available with 9W. 5 Not available with 33W 6 For use with 16W and lower only. 7 Not available with 347V. For NC and NCSM housings only. NCSM housing requires above ceiling access.*

TRIM FINISH OPTIONS



White | Grey | Black | Bronze | Custom RAL (example) | Custom RAL (example)

Custom colors and primer finish also available

USAI LIGHTING COLLABORATORY
13 Crosby Street
New York, NY 10013
845-234-4050
showroom@usailighting.com

USAI LIGHTING HEADQUARTERS
1126 River Road
New Windsor, NY 12553
T: 845-565-8500
info@usailighting.com

© 2018. USAI, LLC. All rights reserved.
All designs protected by copyright. Covered by US Patents: 8,581,520, 8,456,109, 8,742,695, 9,671,091 and 7,832,889. Patents pending. USAI, BeveLED, Warm Glow Dimming and Color Select are registered trademarks of USAI, LLC.
Revised 06/04/2019

ARUP
Project Number: 271565
Phone: 1 212 896 3000

BeveLED® 2.2 Complete
4.5″ Round Deep Regress Downlight - B4RC

USAI® Lighting

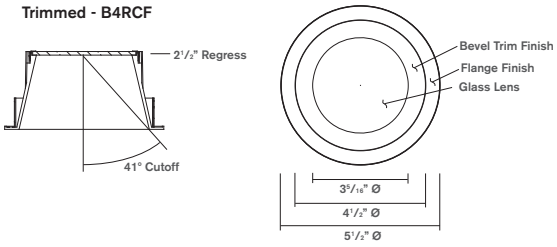
Type:

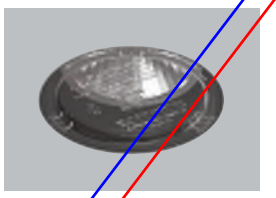
AD02

Trimmed - B4RCF

TRIM DETAILS

Trimmed - B4RCF

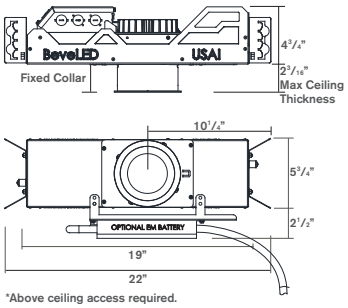




Clear acrylic overspray protector provided standard with every housing to keep out dust and contaminants during construction. Allows for use as work light.

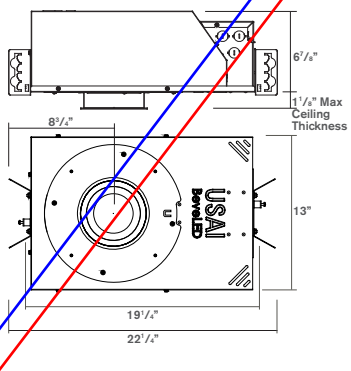
HOUSING OPTIONS

New Construction Narrow Width - NCSM
NCSM with Emergency Battery*

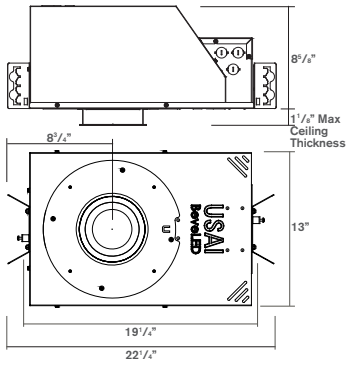


*Above ceiling access required.

New Construction - NC
Insulation-Contact Rated (24W Max) - NCIC
Chicago Plenum Rated (24W Max) - NCCP
NC with Emergency Battery



Insulation-Contact Rated (32W-33W) - NCIC
Chicago Plenum Rated (32W-36W) - NCCP



USAI LIGHTING COLLABORATORY
13 Crosby Street
New York, NY 10013
845-234-4090
showroom@usailighting.com

USAI LIGHTING HEADQUARTERS
1126 River Road
New Windsor, NY 12553
T: 845–565–8500
info@usailighting.com

©2018. USAI, LLC. All rights reserved.
All designs protected by copyright. Covered by US Patents: 8,581,520, 8,456,109, 8,742,695, 9,671,091 and 7,832,889.
Patents pending. USAI, BeveLED, Warm Glow Dimming and Color Select are registered trademarks of USAI, LLC.
Revised 06/04/2019

ARUP
Project Number: 271565
Phone: 1 212 896 3000

BeveLED® 2.2 Complete
4.5" Round Deep Regress Downlight - B4RC

USAI® Lighting

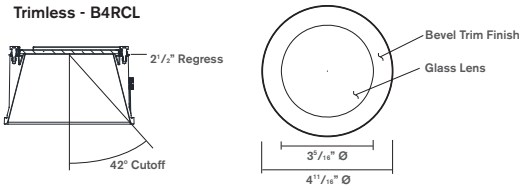
Type:

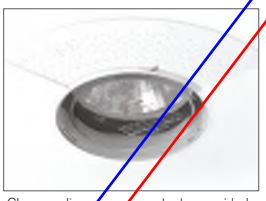
AD02

Trimless - B4RCL

TRIM DETAILS

Trimless - B4RCL

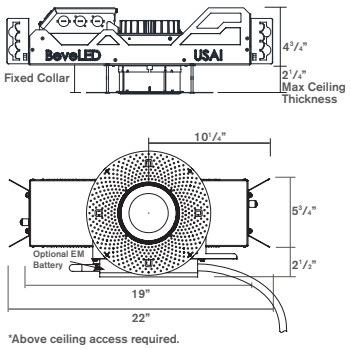




Clear acrylic overspray protector provided standard with every housing to keep out dust and contaminants during construction. Allows for use as work light.

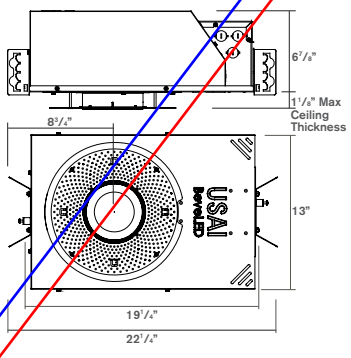
HOUSING OPTIONS

New Construction Narrow Width - NCSM
NCSM with Emergency Battery*

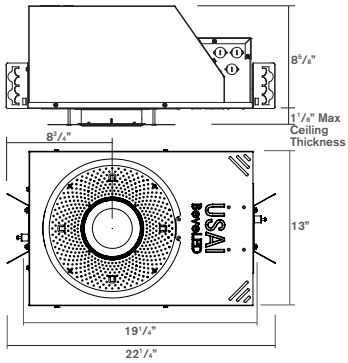


*Above ceiling access required.

New Construction - NC
Insulation-Contact Rated (24W Max) - NCIC
Chicago Plenum Rated (24W Max) - NCCP
NC with Emergency Battery



Insulation-Contact Rated (32W-33W) - NCIC
Chicago Plenum Rated (32W-36W) - NCCP



USAI LIGHTING COLLABORATORY
13 Crosby Street
New York, NY 10013
845-234-4990
showroom@usailighting.com

USAI LIGHTING HEADQUARTERS
1126 River Road
New Windsor, NY 12553
T: 845-565-8500
info@usailighting.com

© 2018. USAI, LLC. All rights reserved.
All designs protected by copyright. Covered by US Patents: 8,581,520, 8,456,109, 8,742,695, 9,671,091 and 7,832,889. Patents pending. USAI, BeveLED, Warm Glow Dimming and Color Select are registered trademarks of USAI, LLC.
Revised 06/04/2019

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page

Remove page

BeveLED® 2.2 Complete
4.5″ Round Deep Regress Downlight - B4RC

USAI® Lighting

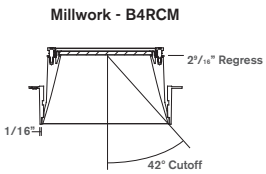
Type:

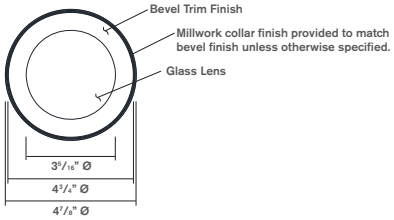
AD02

Millwork - B4RCM

TRIM DETAILS

Millwork - B4RCM

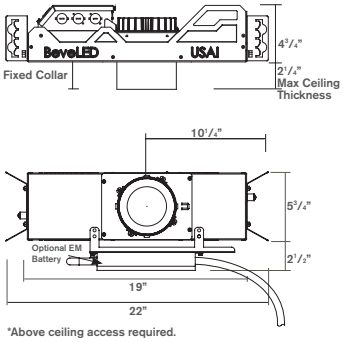




Clear acrylic overspray protector provided standard with every housing to keep out dust and contaminants during construction. Allows for use as work light.

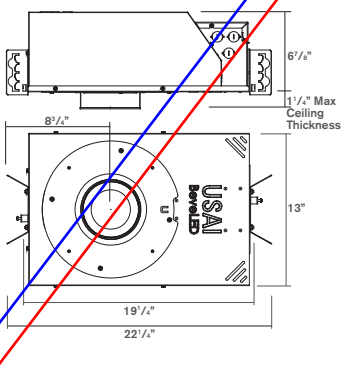
HOUSING OPTIONS

New Construction Narrow Width - NCSM
NCSM with Emergency Battery*

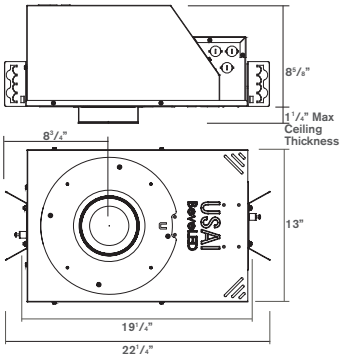


*Above ceiling access required.

New Construction - NC
Insulation-Contact Rated (24W Max) - NCIC
Chicago Plenum Rated (24W Max) - NCCP
NC with Emergency Battery



Insulation-Contact Rated (32W-33W) - NCIC
Chicago Plenum Rated (32W-36W) - NCCP



USAI LIGHTING COLLABORATORY
13 Crosby Street
New York, NY 10013
845-234-4090
showroom@usailighting.com

USAI LIGHTING HEADQUARTERS
1126 River Road
New Windsor, NY 12553
T: 845-565-8500
info@usailighting.com

© 2018. USAI, LLC. All rights reserved.
All designs protected by copyright. Covered by US Patents: 8,581,520, 8,456,109, 8,742,695, 9,671,091 and 7,832,889. Patents pending. USAI, BeveLED, Warm Glow Dimming and Color Select are registered trademarks of USAI, LLC.
Revised 06/04/2019

ARUP
Project Number: 271565
Phone: 1 212 896 3000

BeveLED® 2.2 Complete
4.5" Round Deep Regress Downlight - B4RC

USAI® Lighting

Type:

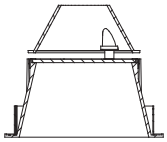
AD02

BEVELED 2.2 SPECIFICATIONS

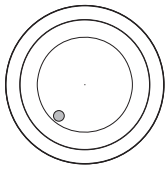
FIELD REPLACEABLE LED LIGHT ENGINE
is serviceable through the aperture without tools or with a Philips screwdriver. All USAI Lighting light engines feature industry-leading color consistency.

FIELD REPLACEABLE DRIVER
Unless otherwise specified, a 0-10V, 100%-1% solid state electronic constant current integral D6E dimming driver with a high power factor is provided standard and sources 2mA. All integral dimming drivers are located within the fixture housing and are serviceable from below the ceiling through the aperture. Some on-time delay may be experienced depending on control system used. All dimming drivers comply with IEEE C62.41 surge protection.

EMERGENCY BATTERY
IOTA emergency battery provides backup power for 90 minutes. NC EM fixtures are provided with an integral emergency battery with integral test switch and can be serviced through the aperture from below the ceiling plane. NCSM EM fixtures are provided with an integral emergency battery with a remote test switch, which comes with a 24" lead length for location of the test switch. Remote EM test switch is dry/damp only; select EMW emergency option for a wet location-rated EM test switch. NCSM EM fixtures require above ceiling access for service of the EM pack. Fixtures that have no USAI EM option may be connected to an inverter (by others) for emergency lighting. Battery is not available with 347V.



Integral Emergency Test Switch included with NC housing



Remote Emergency Test Switch included with NCSM housing (above ceiling access required).

HOUSING
All BeveLED 2.2 fixtures are field-flexible which allows for field changes from trimless to trimmed or millwork with a simple components change with parts from USAI. Housings are fabricated of 20 ga. steel construction with thru wire J-box, 4 in 4 out at min 90°C, #12 AWG thru branch circuit wiring, except for NCSM which is fabricated of 18 ga. steel. NCIC housing for use with 9W, 12W, and 16W light engines only are rated for direct contact with spray foam insulation of R-42 or less.

MOUNTING
B4RCF overlap flange fixtures are designed for use in sheetrock, acoustical ceiling tile, and many other ceiling materials. B4RCL trimless fixtures are provided with a spackle collar and are designed for use in sheetrock/mud-in ceiling applications. B4RCM millwork fixtures are provided with a millwork collar in finish to match trim finish specified and are designed for use in wood/millwork, stone and tile construction applications. Butterfly brackets and residential grade adjustable nailer bars extendible from 14" to 24" centers with integral nails are provided standard for attachment to building structure. C-channel bars are optionally available for acoustical ceiling applications.

Residential-grade nailer bars provided standard.

FIXTURE WEIGHT
NC, NCIC, and NCCP housings weigh 16 lbs. NCSM housing weighs 10 lbs. NCSM with EM weighs 16.5 lbs, and NC housing with EM weighs 24.5 lbs.

WARRANTY
Based on IESNA LM80-2008, BeveLED has a 50,000 hour rated life at 70% lumen maintenance (L70). USAI Lighting Warranty covers replacement parts for 5 years from date of shipment. Ambient temperatures at fixture location should not exceed 40°C during normal operation.

CEILING CUT OUT
B4RCF Trimmed Overlap Flange: 5-1/16" ∅
B4RCL Trimless Spackle-in: 5-1/2" ∅
B4RCM Millwork Knife-edge: 4-15 /16" ∅

LISTINGS
Dry/Damp/Wet location. UL2043 rated for use in air handling plenums. AC and AB trim finishes are dry/damp only. Remote EM test switch is dry/damp only. Select EMW option for wet location remote test switch. NRTL/CSA-US tested to UL standards. IBEW union made.

NOTES
• Use of pressure washer voids warranty

PHOTOMETRICS
Consult factory or website for IES files. Tested in accordance with IESNA LM79.

USAI LIGHTING COLLABORATORY
13 Crosby Street
New York, NY 10013
845-234-4090
showroom@usailighting.com

USAI LIGHTING HEADQUARTERS
1126 River Road
New Windsor, NY 12553
T: 845-565-8500
info@usailighting.com

© 2018. USAI, LLC. All rights reserved.
All designs protected by copyright. Covered by US Patents: 8,581,520, 8,456,109, 8,742,695, 9,671,091 and 7,832,889. Patents pending. USAI, BeveLED, Warm Glow Dimming and Color Select are registered trademarks of USAI, LLC.
Revised 06/04/2019

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page

Remove page

BeveLED® 2.2 Complete
4.5″ Round Deep Regress Downlight - B4RC

USAI® Lighting

Type:

AD02

LED COLOR OPTIONS

Classic White Light

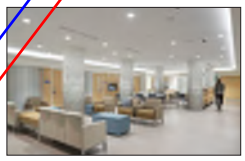
Our proprietary LED light engines achieve a 2-step MacAdam ellipse along the black body locus, resulting in reliable and uniform color from fixture to fixture. You'll see the results in consistently beautiful light throughout your space, whichever USAI LED product you specify.

Warm Glow® Dimming

Warm Glow Dimming provides warmth and glow once possible only in dimmed incandescent sources. Utilizing our patented proprietary algorithm and circuitry, Warm Glow Dimming technologies precisely mimic the black body curve of a standard 100W A19 lamp by gradually transitioning from 2700K , 3000K or 3500K down to 2200K. The result is virtually indistinguishable from an incandescent light source.

Color Select® Tunable White

Color Select represents the next innovation in color temperature control for advanced LED recessed downlighting. Color Select® products allow users to adjust color temperature from 6000K down to 2200K while independently adjusting intensity to achieve ultimate control over the quality of light in a space with a single fixture type. Color Select interfaces with standard dimming and control systems.



USAI LIGHTING COLLABORATORY
13 Crosby Street
New York, NY 10013
845-234-1090
showroom@usailighting.com

USAI LIGHTING HEADQUARTERS
1126 River Road
New Windsor, NY 12553
T: 845-565-8500
info@usailighting.com

© 2018. USAI, LLC. All rights reserved.
All designs protected by copyright. Covered by US Patents: 8,581,520, 8,456,109, 8,742,695, 9,671,091 and 7,832,889.
Patents pending. USAI, BeveLED, Warm Glow Dimming and Color Select are registered trademarks of USAI, LLC.
Revised 06/04/2019

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Manufacturer: iGuzzini : Adjustable Spot Light
Description: Adjustable LED Spot Light

Fixture Wattage: 28 W
Lumen Output: 2060 lumen
Lamp CRI: 90+
Lighting Controls: 0-10V Dimming

Voltage: 120 V
Fixture Finish: White
Lamp CCT: 3000K
Assembly Code: I.PLC S-930-WF-120-X-X-MOD

PALCO SMALL
LED

Type: **SPECIFICATION SHEET**
Project :
Page: 1 of 4

Palco, a veritable family of projectors, considers the work exhibited not only as a physical element, but also its content, the feelings and the message that it is communicating, without forgetting about the space and its contribution to the work. Its shape is inspired by the brush, the main tool used by the artist in the creative process.

Luminaire characteristic:	**Power input:** 7.5 or 29W **Lumens:** from 235 to 2010lm (for 3000K, 90CRI) **Luminaire efficacy:** Up to 69lm/W
Source:	White LED (LM-80 tested) 3000K : 90CRI, 4000K : 80CRI.
Lumen maintenance:	80% of initial lumens at 50 000 hours (L80).
Optic:	Super Spot, Spot, Medium, Flood, Wide Flood or Wall Washer optics.
Material:	Optical body and arm: Die-cast aluminum Accessory holder ring and driver housing: thermoplastic Reflector: formed aluminum (all optics except Super Spot) Lens: methacrylate (only for Super Spot optic) Protective screen: glass.
Mounting:	Track adaptor with circuit selector for two circuit tracks. Also, compatible with TEK or HTEK from Nordic Aluminum.
Electrical:	Integral high efficiency driver 120 / 277V
Dimming:	Leading (Triac) and trailing edge (ELV) for 120V only.
Finish:	White RAL9010, Black.
Weight:	STANDARD: 2.8lbs (1.3kg) WALL WASHER: 3.2lbs (1.4kg)
Warranty:	5 year limited warranty.
Ratings:	IP20
Certification:	cULus listed for dry location.

JP - R7 Last update: February 2020

Due to continuous improvements, the information herein may be changed without notice

9320 Boul. St-Laurent, suite 100, Montréal (Québec) Canada H2N 1N7, P.: 514.523.1339 F.: 514.525.6107 www.iguzzini-na.com

Type:

AH01

Page 1 of 4

Lighting Notes:

1. Finish to be confirmed by architect
2. Provide 10% of fixtures with a hex louver
3. Fixture modified to be surface mounted
4. Provide additional spot and medium reflectors for 5% of fixtures respectively
5. Contractor to coordinate with Architect and Lighting Consultant for final aiming and focus for adjustable fixtures.
6. Trackhead modified to be surface mounted.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

PALCO
SMALL LED

Type:
Project :

SPECIFICATION SHEET
Page: 2 of 4

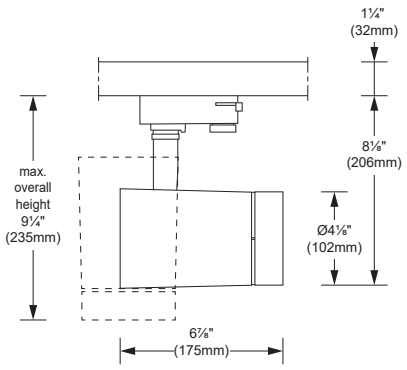
Type:

AH01

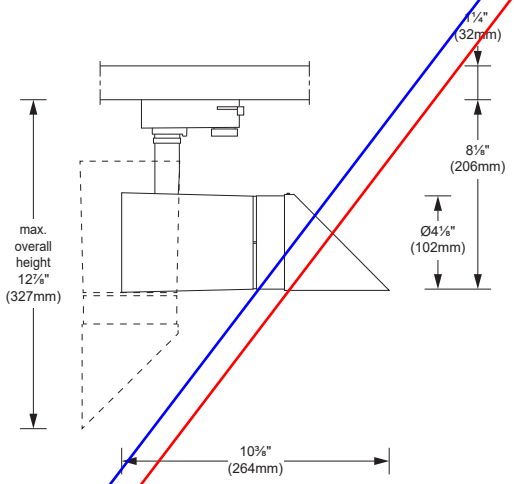
Page 2 of 4

DIMENSION

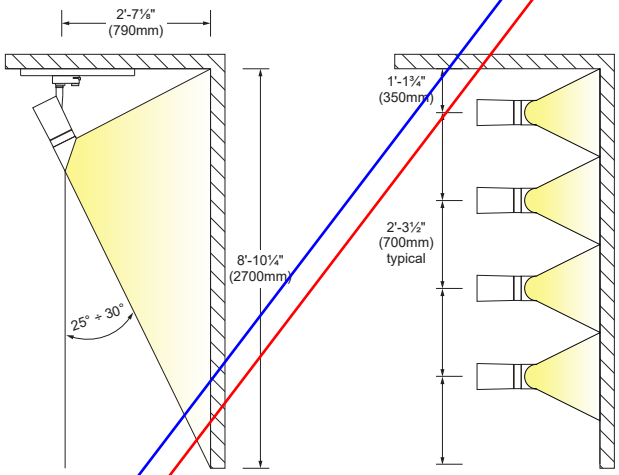
STANDARD
Super Spot, Spot, Medium, Flood and Wide Flood optics



WALL WASHER



WALL WASHER SUGGESTED SPACING AND WALL DISTANCE



SIDE VIEW **TOP VIEW**

Due to continuous improvements, the information herein may be changed without notice
9320 Boul. St-Laurent, suite 100, Montréal (Québec) Canada H2N 1N7, P.: 514.523.1339 F.: 514.525.6107 www.iguzzini-na.com

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page

Remove page

PALCO
SMALL LED

Type:
Project :

SPECIFICATION SHEET
Page: 3 of 4

Type:

AH01

Page 3 of 4

PHOTOMETRIC DATA

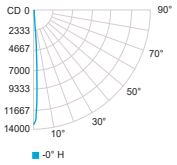
Visit iguzzini.com/us for complete photometric data.

CCT (K)	CRI	LOAD (W)	OPTIC	LUMENS (lm)	EFFICACY (lm / w)	MAX CANDELA (cd)
3000K	90	7.5W	Super Spot(1)	235	31	13 495
		29W	Spot	1960	68	20 965
			Medium	1955	67	11 300
			Flood	1895	65	5 285
			Wide Flood	2010	69	3 830
			Wall Washer	1010	35	1 555

***Use multiplier table for other cct and cri output data**
(1)Not applicable for Super Spot model

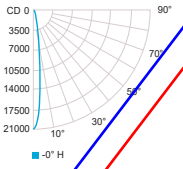
CCT options	4000K
CRI options	80CRI
Multiplier	**1.13**

Super Spot 6° (7.5W - 3000K - 90 CRI)



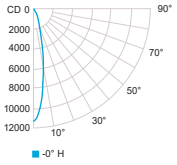
	Center Beam fc	Beam Width ft
2ft	3374	0.2
4ft	843	0.4
6ft	375	0.7
8ft	211	0.9
10ft	135	1.1
12ft	93.7	1.3

Spot 12° (29W - 3000K - 90 CRI)



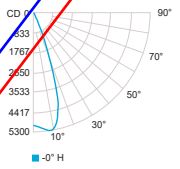
	Center Beam fc	Beam Width ft
2ft	5242	0.4
4ft	1310	0.9
6ft	582	1.3
8ft	328	1.8
10ft	210	2.2
12ft	146	2.7

Medium 20° (29W - 3000K - 90 CRI)



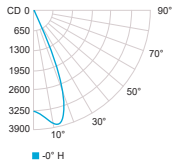
	Center Beam fc	Beam Width ft
2ft	2826	0.7
4ft	707	1.4
6ft	314	2.1
8ft	177	2.8
10ft	113	3.5
12ft	78.5	4.2

Flood 38° (29W - 3000K - 90 CRI)



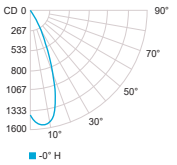
	Center Beam fc	Beam Width ft
2ft	1252	1.3
4ft	313	2.7
6ft	139	4.0
8ft	78.3	5.3
10ft	50.1	6.6
12ft	34.8	8.0

Wide Flood 46° (29W - 3000K - 90 CRI)



	Center Beam fc	Beam Width ft
2ft	826	1.5
4ft	206	3.0
6ft	91.8	4.5
8ft	51.6	6.0
10ft	33	7.5
12ft	22.9	9.0

Wall Washer (29W - 3000K - 90 CRI)



PALCO
SMALL LED

Type:
Project :

SPECIFICATION SHEET
Page: 4 of 4

Type:

AH01

Page 4 of 4

ORDERING INFO

I.PLC S - - - - -
FIXTURE

RESET

MODEL

■ **I.PLC S** - Small

LED

☐ **840** - 4000K, 80 CRI ☐ **930** - 3000K, 90 CRI

OPTIC

☐ **SS** - Super Spot(1) ☐ **SP** - Spot ☐ **MD** - Medium ☐ **FL** - Flood
☐ **WF** - Wide Flood ☐ **WW** - Wall Washer

VOLTAGE

☐ **120** - 120V ☐ **277** - 277V

FINISH

☐ **01** - White ☐ **02** - Black

DIMMING

☐ **LTE** - Leading and Trailing edge dimming (120V only)

(1) Only available with 3000K, 90CRI LED **(930)**

ACCESSORIES (TO BE ORDERED SEPARATELY)
for installation consult the instruction sheet

INTERCHANGEABLE REFLECTORS

☐ **I.MXW5-12** - Spot ☐ **I.MXW6-12** - Medium ☐ **I.MXW7-12** - Flood ☐ **I.MXW8-12** - Wide Flood

LENS (Maximum 1 per fixture)

☐ **I.MXD8-24** - Soft focus lens

☐ **I.MXB7-24** - Medium elliptical lens
☐ **I.MXC0-24** - Large elliptical lens
☐ **I.MY34-24** - Opti beam elliptical lens(1)

OPTICAL ACCESSORIES

☐ **I.MXF0-02** - Louvre (black)(2)
☐ **I.MY90-02** - Opti beam louvre (black)

☐ **I.MXF3-01** - Antiglare screen (white)(3)
☐ **I.MXF3-02** - Antiglare screen (black)(3)

☐ **I.MXF6-02** - Directional flaps (black)

(1) Only available for **Super Spot (SS)**
(2) Must be used with **I.MXD8** lens.
(3) Only available for **Super Spot (SS)** and **Spot (SP)** optics and **I.MXD8** must be used with **Spot (SP)** optic assembly.

iGuzzini NORTH AMERICA
9320 Boul. St-Laurent, suite 100, Montréal (Québec) Canada H2N 1N7, P.: 514.523.1339 F.: 514.525.6107 www.iguzzini-na.com

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Manufacturer: LITHONIA LIGHTING : ZL1N
Description: Suspended Striplight

Fixture Wattage: 48 W
Lumen Output: 5642 lumen
Lamp CRI: 90+
Lighting Controls: 0-10V Dimming

Voltage: 120 V
Fixture Finish: White
Lamp CCT: 3000K
Assembly Code: ZL1N-L96-SMR-6000LM-SBL-FST-120-30K-90CRI-WH-ZACVH

LITHONIA LIGHTING®

FEATURES & SPECIFICATIONS

INTENDED USE — Built on the compact, low-profile Z strip channel, this LED strip offers long maintenance-free life, several color temperatures, lumen outputs and lengths. Ideal for new construction and retrofit applications in T5 and T8 lengths. Ideal for uplight and downlight in commercial, retail, manufacturing, warehouse, cove and display applications. **Certain airborne contaminants can diminish the integrity of acrylic and/or polycarbonate.** Click here for Acrylic-Polycarbonate Compatibility table for suitable uses.

CONSTRUCTION — Compact-design channel and cover are formed from code-gauge cold-rolled steel. Easy to install row aligner included for continuous row mounting.

Finish: Paint options include high-gloss, baked white enamel (WH), galvanized (GALV), matte black (MB) and smoke gray (SKGY). After fabrication, five-stage iron phosphate pre-treatment ensures superior paint adhesion and rust resistance.

OPTICS — Standard diffuse snap on/snap off lens eliminates pixels, improves uniformity and minimizes glare. L/LENS option available.

ELECTRICAL — L70>60,000hours. Utilizes high-output LEDs integrated on a two-layer circuit board, ensuring cool-running operation. Optional internal pluggable wiring harness for reduced labor cost in row mounting applications. (See PLR_ ordering information on page 3.) Electronic LED driver is rated for 75 input watts maximum (see Operational Data on page two for actual wattage consumption), **multi-volt input and 0-10V dimming standard**. This fixture is designed to withstand a maximum line surge of 2.5kV at 0.75kA combination wave for indoor locations, for applications requiring higher level of protection additional surge protection must be provided.

LEDs provide nominal 80 CRI at 3000 K, 3500 K,4000 K, or 5000 K.

Lumen output up to 2,000 lumens per foot. In 86°F (30°C) ambient environments. Luminaire should be installed in applications where ambient temperatures do not exceed 86°F (30°C).

INSTALLATION — Tool-less channel cover for easy installation.

Fixture may be surface mounted (with or without ZSPRG hanger), pendant or stem mounted with appropriate mounting options. Three-point aligner locks in place for easy continuous row mounting.

LISTINGS — CSA certified to US and Canadian safety standards. For use in damp locations between -40°F (-40°C) and 86°F (30°C).

DesignLights Consortium® (DLC) qualified product. Not all versions of this product may be DLC qualified. Please check the DLC Qualified Products List at www.designlights.org to confirm which versions are qualified.

WARRANTY — 5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/support/customer-support/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application.

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

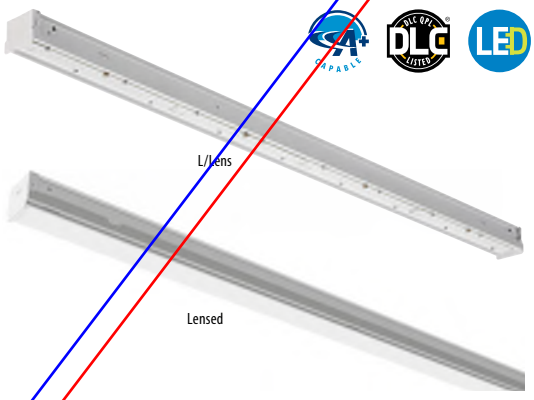
Catalog Number	
Notes	
Type	

Z SERIES

LED Striplight

ZL1N

24", 48" and 96" Lengths



A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® or XPoint™ Wireless control networks marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

Type:
AL02w
Page 1 of 6

Lighting Notes:

1. Mounting detail to be coordinated with Architect.
2. Coordinate suspension length according to architectural drawings.
3. Provide suspension accessories: AIRCRAFT CABLE

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:
AL02w
Page 2 of 6

ZL1N LED Striplight

A+ Capable options indicated by this color background.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: ZL1N L48 3000LM FST MVOLT 40K 80CRI WH

Series		Length		Reflectors[2]		Nominal lumens[3]		Diffuser		Voltage	
ZL1N	LED striplight	L24	24"[1]	(blank)	Less reflector	1500LM	1,500 lumens	FST	Snap on frosted, diffuse	MVOLT	120-277V
				SMR	Symmetric	2500LM	2,500 lumens	L/LENS	No diffuser	120	120V
						3500LM	3,500 lumens	SBL FST	Straight blade louver with snap on frosted, diffuse	208	208V
		L46	46"	(blank)	Less reflector	3000LM	3,000 lumens			240	240V
		L48	48"	ASR	Asymmetric (L48 only)	5000LM	5,000 lumens			277	277V
				SMR	Symmetric	7000LM	7,000 lumens			347	347V[4]
TZL1N	LED striplight	L92	92"	(blank)	Less reflector	6000LM	6,000 lumens			480	480V[4]
		L96	96"	SMR	Symmetric	10000LM	10,000 lumens				
						14000LM	14,000 lumens				

Color temperature		Color rendering index		Options			Paint finish	
30K	3000 K	80CRI	80 CRI	PLR___	Plug-in wiring[5,6]	**Individual Controls**[5]	WH	White
35K	3500 K	90CRI	90 CRI	PLR1LVG	Plug-in wiring-low voltage[5,6]	LBOZU	GALV	Galvanized
40K	4000 K			E7W	Emergency battery pack, 7W CA Title 20 Noncompliant[7]	360° low mount motion sensor, pre-wired[10]	MB	Matte black
50K	5000 K			2E7W	Two Emergency battery packs, 7W CA Title 20 Noncompliant[7,8]	LBH0SZU 360° low mount motion sensor with dimming, pre-wired[10]	SKGY	Smoke gray
				E10WLCP	Emergency battery pack, 10W Linear Constant Power, Certified in CA Title 20 MAEDBS[7]	LBPZU 360° low mount motion sensor with photocell, pre-wired[10]		
				2E10WLCP	Two Emergency battery packs, 10W Linear Constant Power, Certified in CA Title 20 MAEDBS[7,8]	LBM0SZU 360° low mount motion sensor, dimming & switching photocell, pre-wired[10]		
				E15WLCP	Emergency battery pack, 15W Linear Constant Power, Certified in CA Title 20 MAEDBS[7,8]	**Cord sets:**[11]		
				OUTEND	Cord set to exit endplate of fixture	CS1W Straight plug, 120V		
				Wireless Controls[5]		CS3W Twist-lock, 120V		
				NLTAIR2 RLSXR10	nLight Air Generation 2 Fixture mount, LSXR sensor low mount 360˚	CS7W Straight plug, 277V		
				NLTAIR2 RLSXR10EM	nLight Air Generation 2 Fixture mount, LSXR sensor low mount 360˚, UL924 Emergency operation[9]	CS11W Twist-lock, 277V		
						CS25W Twist-lock, 347V		
						CS97W Twist-lock, 480V		
						CS93W 600V SEOOW white cord, no plug (no voltage required)		

Accessories: *Order as separate catalog number.*

HC36	Hanger chain, 36"	ZLR L24 SYM WH	24" symmetric reflector, white finish
ZACVH	Aircraft cable 10' (one pair)	ZLR L46 SYM UPL WH	46" symmetric reflector with uplight, white finish
ZLANGBKT	Luma-tilt™ angle bracket for shelf or ledge mounting only	ZLR L46 SYM WH	46" symmetric reflector, white finish
SQ_	Stem kit, 2" increments up to 48"	ZLR L48 ASY WH	48" asymmetric reflector, white finish
NPP16D	nLight® switching/dimming module	ZLR L48 SYM UPL WH	48" symmetric reflector with uplight, white finish
rPP20D	nLight® Air switching/dimming module	ZLR L48 SYM WH	48" symmetric reflector, white finish
LSXR	Sensor Switch® LSXR occupancy sensor[4]	ZLR L92 SYM UPL WH	92" symmetric reflector with uplight, white finish
ZSPRG	For 15/16" T-grid only	ZLR L92 SYM WH	92" symmetric reflector, white finish
WGZ24	24" wireguard, white[12]	ZLR L96 SYM UPL WH	96" symmetric reflector with uplight, white finish
WGZ48	48" wireguard, white[12,13]	ZLR L96 SYM WH	96" symmetric reflector, white finish
ZLR L24 SYM UPL WH	24" symmetric reflector with uplight, white finish	UNIVERSAL REFL ALIGNER	Universal reflector aligners, quantity 1

Notes

1 Not available with 347V, 480V or Batteries
2 Optional. Reflectors ship separately.
3 See Operational Data on page 2 for actual lumens.
4 Utilizes step down transformer.
5 See ordering information on pages 4 and 5 and rLSXR specification sheet for more configurations. When choosing Sensor and PLR for same fixture, consult the factory.
6 Not available with cord sets.
7 MVOLT only. Not available with cord sets with plugs. Battery Spec sheet linked for more information.
8 Only available with 10,000LM and 14,000LM packages.
9 MVOLT only.
10 Available with MVOLT, 347V and 480V only. This sensor configuration is suitable for minimum ambient temperature of 14°F (-10°C). See page 6 for low temperature option providing -4°F (-20°C) minimum ambient Sensors come prewired, they must be snapped into place at time of installation.
11 Cordsets exit back of fixture unless OUTEND option is specified. Must specify voltage (not required when ordering CS93W).
12 Not compatible with reflector
13 Order 2 for tandem double length fixtures (TZL1N).

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:
AL02w
Page 3 of 6

ZL1N LED Striplight

OPERATIONAL DATA

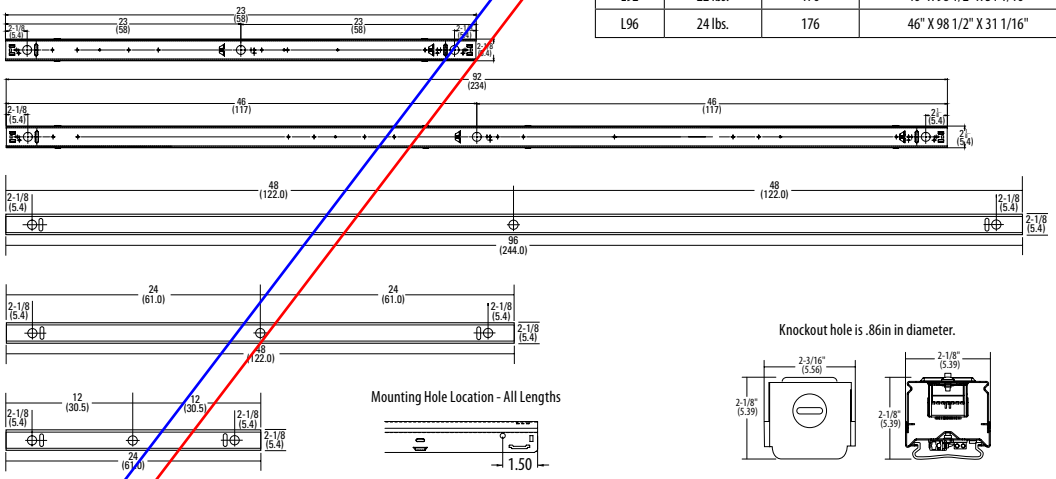
	Nominal lumen package	Length (inches)	Delivered Lumens 3000 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 3500 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 4000 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 5000 K CCT @ 77°F (25°C) ambient temperature		Wattage @ 120V/277V	Comparable Light Source
			80 CRI	90 CRI	80 CRI	90 CRI	80 CRI	90 CRI	80 CRI	90 CRI		
Lensed	1500LM	24	1738	1409	1777	1467	1804	1494	1871	1528	15	1-lamp 17W T8
	2500LM	24	2265	1846	2315	1900	2351	1947	2438	1991	19	1-lamp 17W T8
	3500LM	24	3586	2924	3666	3026	3723	3084	3860	3152	31	1-lamp 32W T8, 1-lamp 54W T5HO, 50W HID
	3000LM	46 or 48	3172	2586	3243	2677	3293	2728	3415	2788	25	1-lamp 32W T8, 1-lamp 54W T5HO, 50W HID
	5000LM	46 or 48	4417	3601	4515	3727	4585	3798	4754	3882	34	2-lamp 32W T8, 1-lamp 54W T5HO, 70W HID
	7000LM	46 or 48	6535	5328	6681	5515	6785	5619	7035	5744	52	3-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	6000LM	92 or 96	6561	5349	6708	5537	6812	5642	7063	5767	48	3-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	10000LM	92 or 96	8687	7082	8881	7331	9019	7470	9351	7636	68	4-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	14000LM	92 or 96	12457	10513	12735	10665	12933	10711	13409	10949	104	4-lamp 32W T8, 3-lamp 54W T5HO, 150W HID
Unlensed	1500LM	24	1881	1534	1923	1588	1953	1618	2025	1654	15	1-lamp 17W T8
	2500LM	24	2452	1999	2506	2069	2545	2108	2639	2155	19	1-lamp 17W T8
	3500LM	24	3882	3165	3969	3276	4031	3338	4179	3412	31	1-lamp 32W T8, 1-lamp 54W T5HO, 50W HID
	3000LM	46 or 48	3434	2800	3511	2898	3565	2953	3697	3019	25	1-lamp 32W T8, 1-lamp 54W T5HO, 50W HID
	5000LM	46 or 48	4781	3898	4888	4035	4964	4111	5147	4203	34	2-lamp 32W T8, 1-lamp 54W T5HO, 70W HID
	7000LM	46 or 48	7075	5768	7233	5971	7345	6083	7616	6219	52	3-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	6000LM	92 or 96	7103	5791	7261	5995	7374	6108	7646	6243	48	3-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	10000LM	92 or 96	9404	7667	9614	7937	9764	8087	10123	8266	68	4-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	14000LM	92 or 96	13485	10994	13786	11381	14001	11596	14516	11853	104	4-lamp 32W T8, 3-lamp 54W T5HO, 150W HID

DIMENSIONS

All dimensions are shown in inches (centimeters) unless otherwise noted.
Specifications subject to change without notice.

PALLET DIMENSIONS

Length	Approximate weight	Fixtures per pallet	Approximate pallet dimensions (L x W x H)
L24	7 lbs.	408	46" X 51" X 32 11/16"
L46	11 lbs.	176	46" X 51" X 32 1/16"
L48	12 lbs.	176	46" X 51" X 31 3/8"
L92	22 lbs.	176	46" X 98 1/2" X 31 1/16"
L96	24 lbs.	176	46" X 98 1/2" X 31 1/16"



PHOTOMETRICS

Please see www.lithonia.com

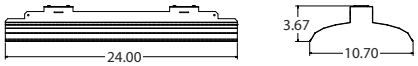
ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:
AL02w
Page 4 of 6

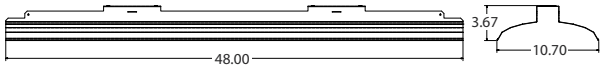
ZL1N LED Striplight

REFLECTORS (Optional)

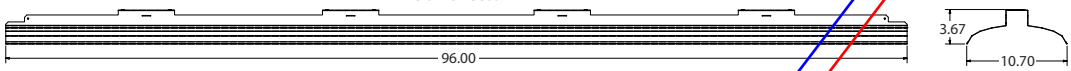
L24 Reflector



L48 Reflector



L96 Reflector



PHOTOMETRICS

Please see www.lithonia.com

PRODUCT INFORMATION

Advanced plug-in system with two-circuit capability. Available on industrial and strip products and a variety of architectural products mounted in continuous rows. 1, 2, 3 and 4-lamp fixtures. PLR22 (2-circuit) and crossover harness switches hot circuit serving next fixture in row. Reduces fixture types on job for alternating circuit applications (see example below.)

Easy one-step installation, saves up to 35% on labor costs. Expanded switching flexibility helps save energy.

Rows can be 50% longer with two-circuit systems. Polarized, lock-together nylon connectors prevent miswiring in the field. #12 THHN conductor, rated 600V, 90°C. White neutral wire included. Grounding accomplished by fixture in-row connectors.

CSA certified systems available with up to 2 circuits. G ground required.

Note: Specifications subject to change without notice.

Wiring

PLR

Advanced 1 or 2-Circuit Plug-In

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Series	Number of hot wires	Branch circuits		Dimming	Ground
PLR	(blank) Not required for 22	Circuits to which ballast is connected	Emergency circuit connected	LV Low-voltage dimming	G Ground, required
PLR22	1 Black	(blank) Not required for 22 or PLR1	(blank) No emergency circuit		
	2 Black and red	A Black wire	ELA Emergency circuit wired to black wire		
		B Red wire	ELB Emergency circuit wired to red wire		

Typical Applications

- Multiple-circuit and single-circuit for longer continuous rows
- Multiple-circuit with alternating fixtures on separate circuits, 2-circuit (PLR 22)
- Multiple circuit with night-lights located along row as desired

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page Remove page

Type:
AL02w
Page 5 of 6

ZL1N LED Striplight

LSXR – Fixture Mount Occupancy Sensor (see www.AcuityControls.com for additional information)

- Three interchangeable lens options to satisfy multiple mounting heights and coverage pattern requirements.
- Integrated mounting bracket drops lens down 3" from chase nipple.
- Single or dual relay versions — designed with robust protection from the harsh switching requirements of T5 and LED loads.
- Photocell and 0-10VDC dimming options.
- No PIR field calibration or sensitivity adjustments required.
- Sensor ambient temperature rating of 14°F (-10°C) to 131°F (55°C).

LSXR configuration	Comparable CMRB sensor	Old style sensor nomenclature
For shortest lead times use one of the following LSXR configurations		
LCOZU	CMRB 50	MSI
LCHOSZU	CMRB 50 D	MSID
LCPZU	CMRB 50 P	MSIPED
LAOZU	CMRB 6	MSI360
LAHOSZU	CMRB 6 D	MSI360D
LAPZU	CMRB 6 P	MSI360PED

SELECTIONS BELOW WILL EXTEND ORDER LEAD TIME. CONSULT YOUR SALES REPRESENTATIVE FOR DETAILS.

SINGLE RELAY

ORDERING INFORMATION — **Example**: LAHOSZU

Series	Lens option	Dimming/Photocell	Max. dim level	Min. dim level	Temp/Humidity	Default occupancy time delay
L LSXR passive infrared indoor occupancy sensor	A High mount, 360° B Low mount, 360° C High mount aisleway	O None[1] H High/low occupancy operation P Switching photocell (on/off)[1] M Dimming and switching photocell G Dimming and switching photocell with high/low occupancy operation	0 10 VDC 9 9 VDC 8 8 VDC 7 7 VDC	S Minimum dim level of ballast 1 1 VDC 2 2 VDC 3 3 VDC 4 4 VDC 5 5 VDC 6 6 VDC	Z None T Low temperature[2]	I 30 sec D 2.5 min X 5.0 min R 7.5 min U 10.0 min (with minimum 15 minute on time) V 15.0 min W 20.0 min Y 30.0 min

Notes
1 Max and min dim levels not applicable with this option.
2 Ambient temperature rating of -4°F (-20°C) to 131°F (55°C).

DUAL RELAY (Available with 120, 277, and 347V only)

ORDERING INFORMATION — **Example**: LA2KZU

Series	Lens option	Poles	Operating mode	Temp/Humidity	Default occupancy time delay
L LSXR passive infrared indoor occupancy sensor	A High mount, 360° B Low mount, 360° C High mount aisleway	2 Dual relay	J None K Alternating off relays (promotes even lamp wear) O Alternating off relays w/photocell P Switching photocell(on/off) E Photocell on/off (pole 1 only) F Photocell on/off - both poles (dual set-point)	Z None T Low temperature[1]	I 30 sec D 2.5 min X 5.0 min R 7.5 min U 10.0 min (with minimum 15 minute on time) V 15.0 min W 20.0 min Y 30.0 min

Notes
1 Ambient temperature rating of -4°F (-20°C) to 131°F (55°C).

Example: LENS 50 J100

Replacement lenses: *Order as separate catalog number.*

Series	Lens type		Package quantity	
LENS	6	High mount 360°	[blank]	Single Lens
	10	Low mount 360°	J10	10-pack
	50	High mount aisleway	J100	100-pack

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page

Remove page

Type:
AL02w
Page 6 of 6

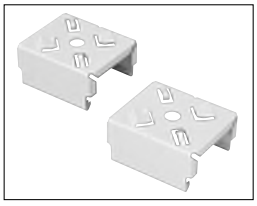
ZL1N LED Striplight

OPTIONS AND ACCESSORIES

The Z Series fixture offers numerous options for almost every electrical and optical component, including a long list of field-installable accessories.

HANGER CHAIN
36" chain with Y hanger.

Order as:
HC36

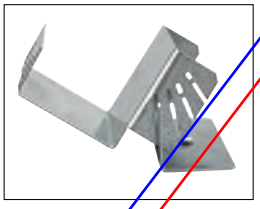


Z SPRING HANGER
Snap 'n' lock design requires no fasteners and can be used on T-grid ceiling or universal mounting systems.

Order as:
ZSPRG

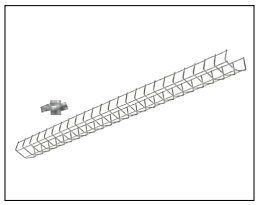
ZACVH HANGER
10' Aircraft cable with Y hanger.

Order as:
ZACVH



ANGLE MOUNTING BRACKET
Luma-tilt™ angle bracket ships as a pair

Order as:
ZLANGBKT



WIRE GUARD

Order as:
WGZ24
WGZ48

© 2013-2020 Acuity Brands Lighting, Inc. All rights reserved.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page Remove page

Manufacturer: LEDLinear : Xooline
Description: Linear Cove Light

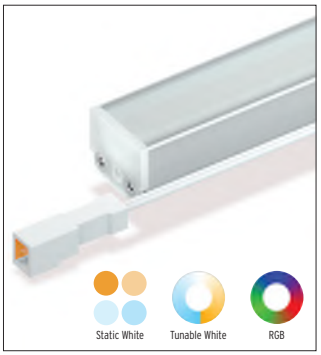
Fixture Wattage: 7.6 W/ft
Lumen Output: 886 lumen/ft
Lamp CRI: 80+
Lighting Controls: 0-10V Dimming

Voltage: 120 V
Fixture Finish: Standard
Lamp CCT: 3000K
Assembly Code: HYD-HD25-W8-30-XX-300-AMC-IP40

Type: AL04

XOOLINE Static White/Tunable White/RGB

LED LINEAR™ lighting solutions — Member of the Fagerhult Group



24 V compact linear indoor LED luminaire offering modularity and ease of installation. Extruded and anodized aluminum housing profile with male/female connectors fed on the luminaire's sides and diffuse screwed end caps for a perfect fixture to fixture light overlap. Allows the use of 11 high quality optics. Clear, semi-opal or opal lenses for soft light settings and linear flat lenses from 10° for wall grazing or 30° and 60° for wide flood illumination with precise light control. Light source assembled using Reel to Reel (R2R) production process supporting LED Linear™ Tj Away® thin flexible circuit board technology. Outstanding lifetime of >60,000 hrs L80/B10 and >30,000 hrs for RGB. Embeds high quality japanese LEDs with 3 step MacAdams (SDCM3) binning centered on target CCT (One Bin Only) with an extended photometric code of Wxxx/339 ensuring an exceptional color consistency over the rated lifetime. Premium color rendition with a CRI of 95 and TM-30-15 up to R_f = 91 / R_g = 100. Consistent light intensity all along the luminaire length. Fully dimmable. Engineered and produced in Germany.

Project name

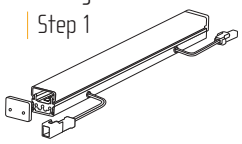
Fixture type | Phase

Specifier | Date

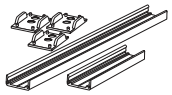
QS Quick Shipping Item — Indicated QS in order codes
Integrated Circuit Driver — Up to 1523 lm/ft 140 lm/W constant light output
Reel-to-Reel R2R Production — High Quality Solder Free Reels
Title 24 — Select Models Only
Intertek ETL Listed
TJAway® Thermal Management — Exceptional Thermal Dissipation
One Bin Only — 3 MacAdam up to 95 CRI
L/B Lifetime — L80/B10 >60,000 hrs /R2R >30,000 hrs
5 Digit Photometric Code — Wxxx/339
IES LM79/LM80 — LM79/LM80 Compliant

Ordering Process

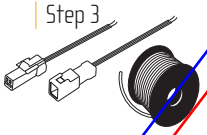
Step 1 — Luminaire (Page 1)



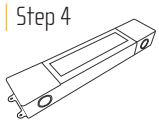
Step 2 — Mounting Accessories (Page 6) (included with luminaire)



Step 3 — Cables and Connectors (Page 6)



Step 4 — Drivers and Controllers (Page 7)



Luminaire Order Code

Family	Model	Lumen package*	Color rendering	Color temperature	Custom length**	Optic/Diffusion	Mounting	Ingress
XOOLINE	_ _ _ _ _	_ _ _ _	W_	_ _	_ _ _ _ _	_ _ _	_ _ _ _	_ _ _ _
	HYD - Static White	LD05–136 lm/ft	W8–85CRI	20–2000K	L_{min}: 381 mm (1'3")	10D 10° Linear Flat Lens	MP Mounting Profile 0°	IP00 Without Optic
		LD10–340 lm/ft QS	W9–95CRI**	22–2200K	L_{max}: 4005 mm (6' 7")	30D 30° Linear Flat Lens	CL0 Mounting Clip 0°	
		LD15–545 lm/ft QS		25–2500K	Increment LD:	60D 60° Linear Flat Lens	CL15 Mounting Clip 15°	
		LD25–886 lm/ft		27–2700K	125 mm [4-15/16"]	OR Round Opal Lens†	CL30 Mounting Clip 30°	IP40 With Optic
		LD40–1159 lm/ft		30–3000K	Increment HD:	DR Round Semi-Opal Lens	CL45 Mounting Clip 45°	
				35–3500K	62.5 mm [2-7/16"]	CR Round Clear Lens	PCL Plastic Clip 0°	
		HD06–164 lm/ft QS		40–4000K		OL Low Square Opal Lens	AMC Adjustable Clip	
		HD10–276 lm/ft QS		50–5000K		DL Low Square Semi-Opal Lens		
		HD15–545 lm/ft QS				CL Low Square Clear Lens		
		HD25–886 lm/ft				OH High Square Opal Lens†		
		HD36–1297 lm/ft				DH High Square Semi-Opal Lens		
						NC Without Lens		
	IQW ATON - Tunable White (2200K - 4000K)	HD12–299 lm/ft	–	–				
		HD24–616 lm/ft QS	–	–				
		HD42–1095 lm/ft	–	–				
	RGB - 622nm (R) 532nm (G) 466nm (B)	LD15–195 lm/ft	–	–				
		HD20–250 lm/ft QS	–	–				

* Lumen Values represent 3000K (W930) and with clear lens. ** Only available for LD05, HD06 and HD10. *** Custom Length should be specified in milimeters (mm). See page 4 and 5 for all available lengths.
† Dot-free

			Low LED Density – Visible Pixellation					High LED Density – Less or No Pixellation				
			LD5 (1.5 W/ft)[A]	LD10 (3.1 W/ft)[A]	LD15 (4.6 W/ft)[A]	LD25 (7.6 W/ft)[A]	LD40 (12.2 W/ft)[A]	HD6 (1.8 W/ft)[A]	HD10 (3.1 W/ft)[A]	HD15 (4.6 W/ft)[A]	HD25 (7.6 W/ft)[A]	HD36 (11 W/ft)[A]
	Color temperature	CCT	Lumen/ft[B]	Lumen/ft[B]	Lumen/ft[B]	Lumen/ft[B]	Lumen/ft[B]	Lumen/ft[B]	Lumen/ft[B]	Lumen/ft[B]	Lumen/ft[B]	Lumen/ft[B]
Static White	W820	2,000 K	115	231	371	603	-	139	231	371	603	883
	W822	2,200 K	133	264	423	691	-	157	264	423	691	1,008
	W825	2,500 K	151	304	484	788	1,026	182	304	484	788	1,151
	W827/W927	2,700 K	136	322	514	837	1,084	161	270	514	837	1,221
	W830/W930	3,000 K	136	340	545	886	1,151	164	276	545	886	1,297
	W835/W935	3,500 K	142	359	572	932	1,224	170	282	572	932	1,361
	W840/W940	4,000 K	145	365	584	953	1,255	173	292	584	953	1,392
	W850	5,000 K	200	398	639	1,041	1,258	240	398	639	1,041	1,523

[A] The given data are typical values. Due to tolerances of the production process and the electrical components, values for light output and electrical power can vary up to 10%.
[B] Measured with clear lens. Light output is reduced by 40% with opal and 25% with semi-opal lens options. The IP protection level is reduced from IP40 to IP00 without lens option (NC).

Lighting Notes:

1. Refer to architectural drawings for fixture length, provide fixture in continuous run as indicated in the architectural drawings.
2. Refer to architectural drawings for mounting details.
3. Coordinate remote driver location with the architect in the nearest accessible location. All wiring cables and leads shall be fully concealed from view.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page Remove page

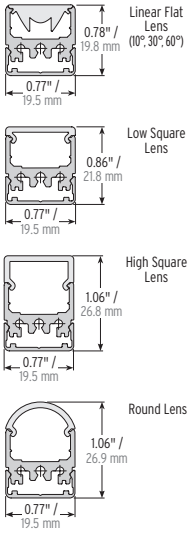
XOOLINE Static White/Tunable White/RGB

LED LINEAR™ lighting solutions | Member of the Fagerhult Group

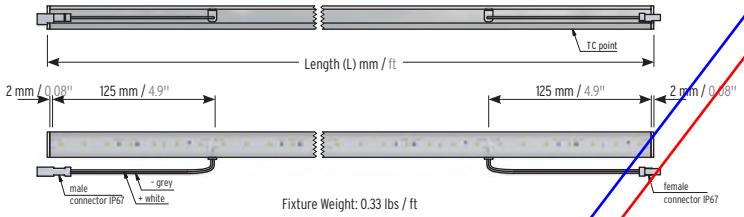
Type:

AL04

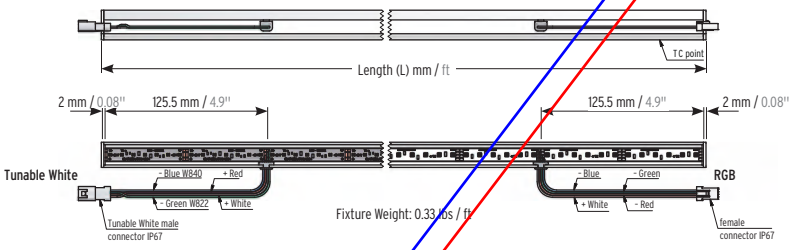
Mechanical Details



Static White - Fixture build to length and is not field cuttable.



Tunable White / RGB - Fixture build to length and is not field cuttable.



Technical Details

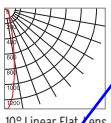
	Static White	Tunable White	RGB
Voltage	24 Volt (23 V_{min}, 25 V_{max})	24 Volt (23 V_{min}, 25 V_{max})	24 Volt (23 V_{min}, 25 V_{max})
Case temperature[A]	Tc_{min} = -13°F, Tc_{max} = specific, see Table below	Tc_{min} = -13°F, Tc_{max} = specific, see Table below	Tc_{min} = -13°F, Tc_{max} = specific, see Table below
Storage temperature	Ts_{min} = -22°F, Ts_{max} = 185°F	Ts_{min} = -22°F, Ts_{max} = 185°F	Ts_{min} = -22°F, Ts_{max} = 185°F
Ambient temperature	Ta_{min} = -13°F, Ta_{max} = specific, see Table below	Ta_{min} = -13°F, Ta_{max} = specific, see Table below	Ta_{min} = -13°F, Ta_{max} = specific, see Table below

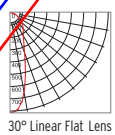
[A] The position of the Tc-point is marked on each step of the LED strip. The Tc-point should be measured in thermal equilibrium according to IEC EN 60598-1.

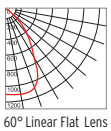
	Static White										Tunable White			RGB	
	LD5	LD10	LD15	LD25	LD40	HD6	HD10	HD15	HD25	HD36	HD12	HD24	HD42	LD15	HD20
Power (W/ft)[B]	1.5	3.1	4.6	7.6	12.2	1.8	3.1	4.6	7.6	11	3.7	7.3	12.8	4.6	6.7
Efficacy (lm / W)[B] @ W850	132	131	140	137	103	132	131	140	137	139	82	84	85	43	44
Max serial run length (ft / m)	24.6 / 7.5	16.4 / 5	13.1 / 4	9.8 / 3	6.6 / 2	16.4 / 5	16.4 / 5	13.1 / 4	9.8 / 3	6.6 / 2	16.4 / 5	13.1 / 4	6.6 / 2	13.1 / 4	13.1 / 4
CRI / R9 @ 3000 K	up to 95 / up to 65										85 / 20	85 / 20	85 / 20	–	–
Temperature Tc-point (Tc_{max})[B]	158°F	158°F	158°F	167°F	185°F	158°F	158°F	158°F	167°F	185°F	158°F	158°F	176°F	158°F	158°F
Max ambient temperature (Ta_{max})	122°F	122°F	104°F	104°F	95°F	122°F	122°F	122°F	113°F	95°F	122°F	104°F	95°F	113°F	113°F

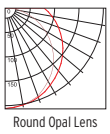
[B] The given data are typical values. Due to tolerances of the production process and the electrical components, values for light output and electrical power can vary up to 10%.

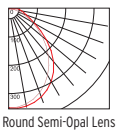
Light Distribution

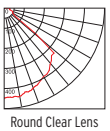

10° Linear Flat Lens

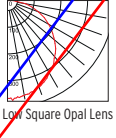

30° Linear Flat Lens

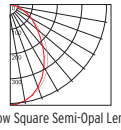

60° Linear Flat Lens

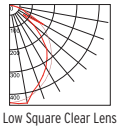

Round Opal Lens

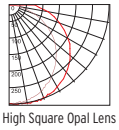

Round Semi-Opal Lens

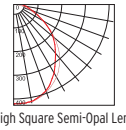

Round Clear Lens


Low Square Opal Lens


Low Square Semi-Opal Lens


Low Square Clear Lens


High Square Opal Lens


High Square Semi-Opal Lens

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:

AL04

XOOLINE Static White/Tunable White/RGB

LED LINEAR™ lighting solutions | Member of the Fagerhult Group

Colorimetric Details

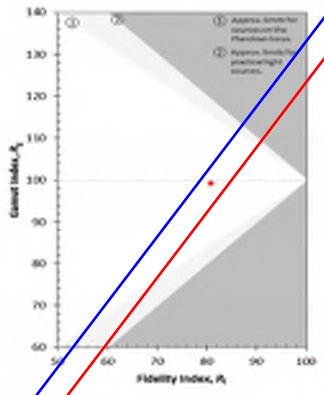
Photometric Code	CCT	CRI	R9	R_f	R_g
W830/339	3000 K	85	23	82	99

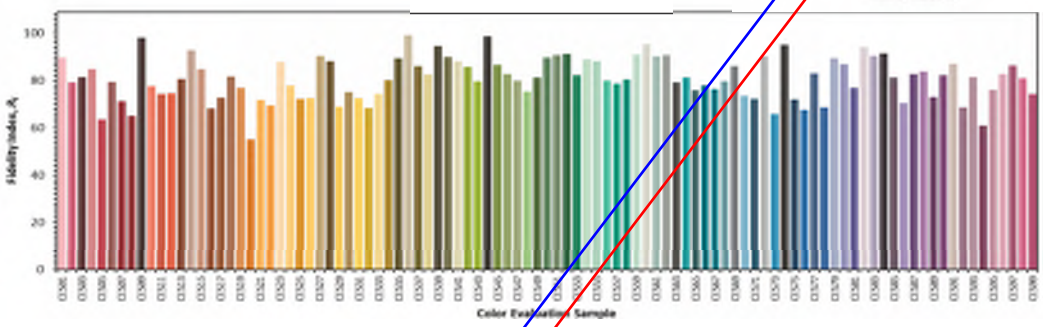
Color Vector Graphic

Reference Illuminant

Test Source

Color Distortion Graphic





Colorimetric Details

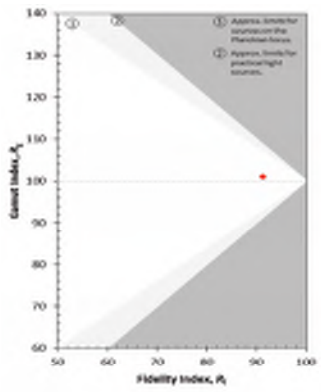
Photometric Code	CCT	CRI	R9	R_f	R_g
W930/339	3000 K	96	70	91	101

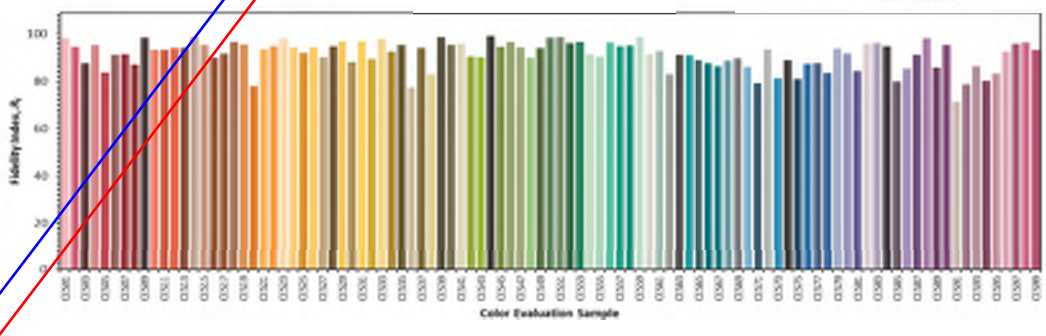
Color Vector Graphic

Reference Illuminant

Test Source

Color Distortion Graphic





ARUP
Project Number: 271565
Phone: 1 212 896 3000

XOOLINE Static White/Tunable White/RGB

LED LINEAR™ lighting solutions | Member of the Fagerhult Group

Type:

AL04

LENGTH CHART - Xooline LD

Standard Length		Static White LD5 1.5 Watts/Ft		Static White LD10 3.0 Watts/Ft		Static White LD15 4.6 Watts/Ft		Static White LD25 7.6 Watts/Ft		Static White LD40 12.2 Watts/Ft		RGB LD15 4.6 Watts/Ft	
inches	mm	Watts/fixture	Lumens/fixture @3000K	Watts/fixture	Lumens/fixture @3000K	Watts/fixture	Lumens/fixture @3000K	Watts/fixture	Lumens/fixture @3000K	Watts/fixture	Lumens/fixture @3000K	Watts/fixture	Lumens/fixture
15.0	380	2	170	4	424	6	679	9	1104	15	1435	6	243
19.9	505	2	225	5	563	8	903	13	1468	20	1907	8	323
24.8	630	3	281	6	703	10	1126	16	1831	25	2378	10	403
29.7	755	4	337	7	842	11	1350	19	2194	30	2850	11	483
34.7	880	4	393	9	981	13	1573	22	2557	35	3322	13	563
39.6	1005	5	448	10	1121	15	1797	25	2921	40	3794	15	643
44.5	1130	6	504	11	1260	17	2020	28	3284	45	4266	17	723
49.4	1255	6	560	12	1400	19	2243	31	3647	50	4738	19	803
54.3	1380	7	616	14	1539	21	2467	34	4010	55	5210	21	883
59.3	1505	7	671	15	1678	23	2690	38	4374	60	5682	23	963
64.2	1630	8	727	16	1818	25	2914	41	4737	65	6154	25	1043
69.1	1755	9	783	17	1957	26	3137	44	5100	70	6626	26	1122
74.0	1880	9	839	18	2097	28	3361	47	5463	75	7098	28	1202
78.9	2005	10	894	20	2236	30	3584	50	5827	80	7569	30	1282
83.9	2130	10	950	21	2375	32	3808	53	6190	–	–	32	1362
88.8	2255	11	1006	22	2515	34	4031	56	6553	–	–	34	1442
93.7	2380	12	1062	23	2654	36	4254	59	6916	–	–	36	1522

Oversize Length		Static White LD5 1.5 Watts/Ft		Static White LD10 3.0 Watts/Ft		Static White LD15 4.6 Watts/Ft		Static White LD25 7.6 Watts/Ft		Static White LD40 12.2 Watts/Ft		RGB LD15 4.6 Watts/Ft	
inches	mm	Watts/fixture	Lumens/fixture @3000K	Watts/fixture	Lumens/fixture @3000K	Watts/fixture	Lumens/fixture @3000K	Watts/fixture	Lumens/fixture @3000K	Watts/fixture	Lumens/fixture @3000K	Watts/fixture	Lumens/fixture
98.6	2505	12	1117	25	2794	38	4473	62	7280	–	–	38	1602
103.5	2630	13	1173	26	2933	40	4701	66	7643	–	–	40	1682
108.5	2755	14	1229	27	3072	42	4925	69	8006	–	–	42	1762
113.4	2880	14	1285	28	3212	43	5148	72	8370	–	–	43	1842
118.3	3005	15	1340	30	3351	45	5372	75	8733	–	–	45	1922
123.2	3130	15	1396	31	3491	47	5595	–	–	–	–	47	2002
128.2	3255	16	1452	32	3630	49	5819	–	–	–	–	49	2082
133.1	3380	17	1508	33	3769	51	6042	–	–	–	–	51	2162
138.0	3505	17	1564	34	3909	53	6266	–	–	–	–	53	2242
142.9	3630	18	1619	36	4048	55	6489	–	–	–	–	55	2322
147.8	3755	18	1675	37	4188	57	6712	–	–	–	–	57	2402
152.8	3880	19	1731	38	4327	59	6936	–	–	–	–	59	2482
157.7	4005	20	1787	39	4466	60	7159	–	–	–	–	60	2562

XOOLINE HD- Continued on next page

ARUP
Project Number: 271565
Phone: 1 212 896 3000

XOOLINE Static White/Tunable White/RGB

LED LINEAR™ lighting solutions | Member of the Fagerhult Group

Type:

AL04

LENGTH CHART - Xooline HD

Standard Length		Static White										Tunable White						RGB	
		HD6 1.8 Watts/Ft		HD10 3.0 Watts/Ft		HD15 4.6 Watts/Ft		HD25 7.6 Watts/Ft		HD36 11 Watts/Ft		HD12 3.7 Watts/Ft		HD24 7.3 Watts/Ft		HD4 12.8 Watts/Ft		HD20 6 Watts/Ft	
inches	mm	Watts/ fixture	Lumens/fixture @3000K	Watts/ fixture	Lumens/fixture @3000K	Watts/ fixture	Lumens/fixture @3000K	Watts/ fixture	Lumens/fixture @3000K	Watts/ fixture	Lumens/fixture @3000K	Watts/ fixture	Lumens/ fixture	Watts/ fixture	Lumens/ fixture	Watts/ fixture	Lumens/ fixture	Watts/ fixture	Lumens/ fixture
15.0	380	2	204	4	344	6	679	9	1104	14	1617	5	373	9	768	16	1365	7	312
17.4	443	3	238	4	401	7	791	11	1286	16	1882	5	434	11	894	19	1589	9	363
19.9	505	3	272	5	457	8	903	13	1468	18	2148	6	495	12	1020	21	1814	10	414
22.3	568	3	305	6	514	9	1014	14	1649	20	2414	7	557	14	1147	24	2038	11	465
24.8	630	4	339	6	570	10	1126	16	1831	23	2680	8	618	15	1273	26	2263	12	517
27.3	693	4	373	7	627	10	1238	17	2012	25	2946	8	679	17	1399	29	2487	14	568
29.7	755	4	406	7	683	11	1350	19	2194	27	3212	9	740	18	1525	32	2712	15	619
32.2	818	5	440	8	740	12	1461	20	2376	29	3478	10	802	20	1652	34	2936	16	670
34.7	880	5	473	9	797	13	1573	22	2557	32	3744	11	863	21	1778	37	3161	17	722
37.1	943	6	507	9	853	14	1685	23	2739	34	4010	11	924	23	1904	40	3385	19	773
39.6	1005	6	541	10	910	15	1797	25	2921	36	4275	12	986	24	2031	42	3610	20	824
42.0	1068	6	574	11	966	16	1908	27	3102	39	4541	13	1047	26	2157	45	3834	21	875
44.5	1130	7	608	11	1023	17	2020	28	3284	41	4807	14	1108	27	2283	47	4059	22	927
47.0	1193	7	641	12	1080	18	2132	30	3466	43	5073	14	1170	29	2409	50	4283	23	978
49.4	1255	7	675	12	1136	19	2243	31	3647	45	5339	15	1231	30	2536	53	4507	25	1029
51.9	1318	8	709	13	1193	20	2355	33	3829	48	5605	16	1292	32	2662	55	4732	26	1080
54.3	1380	8	742	14	1249	21	2467	34	4010	50	5871	17	1353	33	2788	58	4956	27	1132
56.8	1443	9	776	14	1306	22	2579	36	4192	52	6137	18	1415	35	2915	61	5181	28	1183
59.3	1505	9	810	15	1362	23	2690	38	4374	54	6403	18	1476	36	3041	63	5405	30	1234
61.7	1568	9	843	15	1419	24	2802	39	4555	57	6668	19	1537	38	3167	66	5630	31	1285
64.2	1630	10	877	16	1476	25	2914	41	4737	59	6934	20	1599	39	3293	68	5854	32	1337
66.6	1693	10	910	17	1532	26	3026	42	4919	61	7200	21	1660	41	3420	71	6079	33	1388
69.1	1755	10	944	17	1589	26	3137	44	5100	63	7466	21	1721	42	3546	74	6303	35	1439
71.6	1818	11	978	18	1645	27	3249	45	5282	66	7732	22	1782	44	3672	76	6528	36	1490
74.0	1880	11	1011	18	1702	28	3361	47	5463	68	7998	23	1844	45	3799	79	6752	37	1542
76.5	1943	11	1045	19	1759	29	3472	48	5645	70	8264	24	1905	47	3925	82	6977	38	1593
78.9	2005	12	1079	20	1815	30	3584	50	5827	72	8530	24	1966	48	4051	84	7201	39	1644
81.4	2068	12	1112	20	1872	31	3696	52	6008	–	–	25	2028	50	4177	–	–	41	1695
83.9	2130	13	1146	21	1928	32	3808	53	6190	–	–	26	2089	51	4304	–	–	42	1747
86.3	2193	13	1179	22	1985	33	3919	55	6372	–	–	27	2150	52	4430	–	–	43	1798
88.8	2255	13	1213	22	2041	34	4031	56	6553	–	–	27	2212	54	4556	–	–	44	1849
91.2	2318	14	1247	23	2098	35	4143	58	6735	–	–	28	2273	55	4682	–	–	46	1900
93.7	2380	14	1280	23	2155	36	4254	59	6916	–	–	29	2334	57	4809	–	–	47	1952

Oversize Length		HD6 1.8 Watts/Ft		HD10 3.0 Watts/Ft		HD15 4.6 Watts/Ft		HD25 7.6 Watts/Ft		HD36 11 Watts/Ft		HD12 3.7 Watts/Ft		HD24 7.3 Watts/Ft		HD4 12.8 Watts/Ft		HD20 6 Watts/Ft	
inches	mm	Watts/ fixture	Lumens/fixture @3000K	Watts/ fixture	Lumens/fixture @3000K	Watts/ fixture	Lumens/fixture @3000K	Watts/ fixture	Lumens/fixture @3000K	Watts/ fixture	Lumens/fixture @3000K	Watts/ fixture	Lumens/ fixture	Watts/ fixture	Lumens/ fixture	Watts/ fixture	Lumens/ fixture	Watts/ fixture	Lumens/ fixture
96.2	2443	14	1314	24	2211	37	4356	61	7098	–	–	30	2395	58	4935	–	–	48	2003
98.6	2505	15	1347	25	2268	38	4478	62	7280	–	–	30	2457	60	5061	–	–	49	2054
101.1	2568	15	1381	25	2324	39	4590	64	7461	–	–	31	2518	61	5188	–	–	51	2105
103.5	2630	16	1415	26	2381	40	4701	66	7643	–	–	32	2579	63	5314	–	–	52	2157
106.0	2693	16	1448	26	2437	41	4813	67	7825	–	–	33	2641	64	5440	–	–	53	2208
108.5	2755	16	1482	27	2494	42	4925	69	8006	–	–	33	2702	66	5566	–	–	54	2259
110.9	2818	17	1516	28	2551	43	5037	70	8188	–	–	34	2763	67	5693	–	–	55	2310
113.4	2880	17	1549	28	2607	43	5148	72	8370	–	–	35	2824	69	5819	–	–	57	2362
115.9	2943	17	1583	29	2664	44	5260	73	8551	–	–	36	2886	70	5945	–	–	58	2413
118.3	3005	18	1616	30	2720	45	5372	75	8733	–	–	36	2947	72	6072	–	–	59	2464
120.8	3068	18	1650	30	2777	46	5483	–	–	–	–	37	3008	–	–	–	–	60	2515
123.2	3130	18	1684	31	2834	47	5595	–	–	–	–	38	3070	–	–	–	–	62	2567
125.7	3193	19	1717	31	2890	48	5707	–	–	–	–	39	3131	–	–	–	–	63	2618
128.2	3255	19	1751	32	2947	49	5819	–	–	–	–	40	3192	–	–	–	–	64	2669
130.6	3318	20	1785	33	3003	50	5930	–	–	–	–	40	3254	–	–	–	–	65	2720
133.1	3380	20	1818	33	3060	51	6042	–	–	–	–	41	3315	–	–	–	–	67	2772
135.5	3443	20	1852	34	3116	52	6154	–	–	–	–	42	3376	–	–	–	–	68	2823
138.0	3505	21	1885	34	3173	53	6266	–	–	–	–	43	3437	–	–	–	–	69	2874
140.5	3568	21	1919	35	3230	54	6377	–	–	–	–	43	3499	–	–	–	–	70	2925
142.9	3630	21	1953	36	3286	55	6489	–	–	–	–	44	3560	–	–	–	–	71	2977
145.4	3693	22	1986	36	3343	56	6601	–	–	–	–	45	3621	–	–	–	–	73	3028
147.8	3755	22	2020	37	3399	57	6712	–	–	–	–	46	3683	–	–	–	–	74	3079
150.3	3818	23	2054	38	3456	58	6824	–	–	–	–	46	3744	–	–	–	–	75	3130
152.8	3880	23	2087	38	3512	59	6936	–	–	–	–	47	3805	–	–	–	–	76	3182
155.2	3943	23	2121	39	3569	59	7048	–	–	–	–	48	3866	–	–	–	–	78	3233
157.7	4005	24	2154	39	3626	60	7159	–	–	–	–	49	3928	–	–	–	–	79	3284

ARUP

Project Number: 271565
Phone: 1 212 896 3000

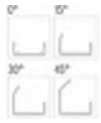
XOOLINE Static White/Tunable White/RGB

LED LINEAR™ lighting solutions | Member of the Fagerhult Group

Type:

AL04

Mounting Accessories – (Included in the luminaire order)

	Item	Description	Dimensions (L x W x H)	Order Type
	Aluminum Mounting Profile	Continuous aluminum surface mounting profile. 6.5 ft long.	6-1/2' x 3/4" x 1/4"	MP
	Aluminum Mounting Clip	Aluminum surface mounting clip, recommended to use every 20 inches. Available in four different angles. 3.5 inches long.	3-1/2" x 3/4" x 1/4" 3-1/2" x 3/4" x 1/2" 3-1/2" x 3/4" x 3/4" 3-1/2" x 3/4" x 7/8"	CL0 CL15 CL30 CL45
	Plastic Mounting Clip	White plastic surface mounting clip. Required for vertical mounting of the fixture. Recommended to use every 20 inches. Cannot be used together with the aluminum mounting profile.	3/4" x 1-1/4" x 1/4"	PCL
	Adjustable Clip	Use to adjust and fix the angle of fixture. 180° adjusting range. Delivered as a pair with screws included.	1/8" x 3/4"	AMC

Cables and Connectors

	Item	Description	Model	Dimensions	Order Code
	Cable IP68 for Static White	Outdoor rated UL approved cable. Use to extend installation distance with outdoor rated splicing box (by others).	Static White	2 x 22 AWG, 160 ft	14000030
	Mini Female Connector IP67 for Static White	Use to run cable from the driver to the first fixture of the run or to the next fixture. Female mini connector on one side and open end cable on the other side.	Static White Static White	2 x 22 Awg, 8 in 2 x 22 Awg, 6.5 ft	15000141 15000142
	Mini Male Connector IP67 for Static White	Use to run cable from the fixture to the driver or to the previous fixture. Male mini connector on one side and open end cable on the other side.	Static White	2 x 22 Awg, 8 in	15000140
	Mini Extension IP67 for Static White	Use to extend the distance between connection points. Female connector on one side and male connector on the other side.	Static White Static White	2 x 22 Awg, 4 in 2 x 22 Awg, 6.5 ft	15000143 15000144
	Cable IP68 for RGB and Tunable White	Outdoor rated UL approved cable. Use to extend installation distance with outdoor rated splicing box (by others).	RGB / Tunable White RGB / Tunable White	4 x 23 Awg, 160 ft 4 x 18 Awg, 160 ft	14000048 14000060
	Mini Female Connector IP67 for RGB and Tunable White	Use to run cable from the driver to the first fixture of the run or to the next fixture. Female mini connector on one side and open end cable on the other side.	RGB Tunable White RGB / Tunable White	4 x 23 Awg, 8 in 4 x 23 Awg, 8 in 4 x 23 Awg, 6.5 ft	15000201 15000241 15000202
	Mini Male Connector IP67 for RGB and Tunable White	Use to run cable from the fixture to the driver or to the previous fixture. Male mini connector on one side and open end cable on the other side.	RGB Tunable White	4 x 23 Awg, 8 in 4 x 23 Awg, 8 in	15000200 15000240
	Mini Extension IP67 for RGB and Tunable White	Use to extend the distance between connection points. Female connector on one side and male connector on the other side.	Static White Static White	4 x 23 Awg, 4 in 4 x 23 Awg 6.5 ft	15000203 15000204

ARUP
Project Number: 271565
Phone: 1 212 896 3000

XOOLINE Static White/Tunable White/RGB

LED LINEAR™ lighting solutions | Member of the Fagerhult Group

Type:

AL04

Drivers

Item		Specifications	Downloads
LED LINEAR™ Non-Dimmable Drivers		• UL 8750 Listed Enclosure - With Built-In Junction Boxes • Universal Input Voltage 120V - 277V • IP65 - For Both Indoor and Outdoor Use • No Minimum Load Requirement • 24V Constant Voltage Output, Class 2 • Available in three wattages 30W, 60W and 96W • Max. Dimensions: 12-1/8" x 2-3/8" x 1-3/8"	30 W SPEC SHEET 60 W SPEC SHEET 96 W SPEC SHEET INSTALLATION INSTRUCTIONS
LED LINEAR™ 0-10V Dimmable Drivers		• UL 8750 Listed Enclosure - With Built-In Junction Boxes • 0-10V Dimmable - Flicker Free Down to 1% • Universal Input Voltage 120V - 277V • IP65 - For Both Indoor and Outdoor Use • 24V Constant Voltage Output, Class 2, Class P • Available in three wattages 30W, 60W and 96W • Max. Dimensions: 12-1/8" x 2-3/8" x 1-3/8"	30 W SPEC SHEET 60 W SPEC SHEET 96 W SPEC SHEET INSTALLATION INSTRUCTIONS
LED LINEAR™ ELV/Triac Dimmable Drivers		• UL 8750 Listed Class 2 Enclosure • 24V constant voltage output • Compact size yet high efficiency and performance in dry and damp environments (IP67) • Multiple Inputs: 120V or 277V • Fully dimmable: ELV Dimmers - Reverse or Adaptive Phase Control, Trailing Edge • Available in two wattages 48W and 96W • Multiple Circuits are available up to 4 units (up to 384W)	48 W SPEC SHEET 96 W SPEC SHEET INSTALLATION INSTRUCTIONS
MW PWM Dimmable Drivers		• Universal AC input / Full range (up to 305VAC) • Constant voltage PWM style output • Built-in 3 in 1 dimming function (0~10Vdc or PWM signal or resistance) • Dimming range : 0~100% • Class 2 power unit • Suitable for dry / damp / wet locations • UL Recognized component, 5 years warranty	40 W SPEC SHEET 60 W SPEC SHEET 90 W SPEC SHEET INSTALLATION INSTRUCTIONS
OLUTRON Dimmable Drivers		• UL Listed Enclosure • Dimming Range: 100% to 1% and 0.1% (Premiere) • LED lighting turns on to any dimmed level without flashing to full brightness • Operating Voltage: 120V~ to 277V~ at 50/60 Hz • Rated lifetime of 50,000 hours at 40°C (104°F) ambient temperature and maximum loading • For rated warranty, ambient temperature not to exceed 40°C (104°F) • Open-circuit protected output	HI-LUME SPEC SHEET HI-LUME PREMIERE SPEC SHEET INSTALLATION INSTRUCTIONS
eldoLED DALI/DMX Dimmable Drivers		• Available in linear or rectangular format • 100W, DMX/DALI interface for Static White, Tunable White and RGB/W Applications • 4 control channels • 24V constant voltage, 4 x 24V outputs • Metal or plastic case options	100 W SPEC SHEET INSTALLATION INSTRUCTIONS

Controllers

Item		Specifications	Downloads
eldoLED Controllers		**180/D** DMX Controller for RGB/W and Tunable White Applications **210/D** Dali Contoller for Static White Applications **211/D-LG** 0-10V Logarithmic Dimming Controller **211/D-LN** 0-10V Linear Dimming Controller **212/D** DMX Controller for Static White and Static Color Applications **DimWheel** DMX Wall Controller for RGB/W and Tunable White Applications	180/D SPEC SHEET 210/D SPEC SHEET 211/D-LG SPEC SHEET 211/D-LN SPEC SHEET 212/D SPEC SHEET DIM WHEEL SPEC SHEET

Click for more information

PRODUCT BROCHURE | INSTALLATION | IES FILES | DRIVERS & CONTROLS

LED LINEAR TECHNOLOGY | QUICK SHIPPING | VOLTAGE DROP CALCULATOR

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Manufacturer: Coronet : LS3 LED
Description: Surface Mounted Linear

Fixture Wattage: 10 W/ft
Lumen Output: 770 lumen/ft
Lamp CRI: 80+
Lighting Controls: 0-10V Dimming

Voltage: 120 V
Fixture Finish: White
Lamp CCT: 3000K
Assembly Code: LS3 LED X 3000/90 LTG3 UNV DB X SM SD X EM120V

Type: AL05

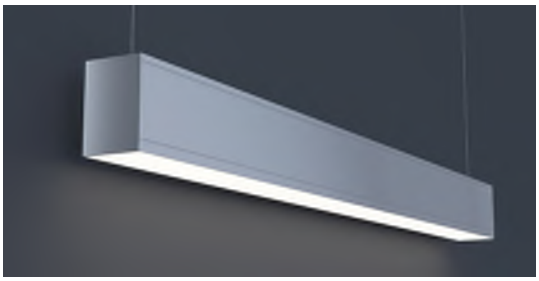
Lighting Notes:

1. Refer to architectural drawings for fixture length.
2. Finish to be confirmed by architect.
3. Mounting and installation of conduit and routing path to be coordinated with architect.

Coronet

LS3 LED

DATE	PROJECT	FIRM	TYPE



Linear, architectural luminaire. For use in indoor applications where an LED luminaire providing continuous light is required. Suspended, surface or wall mounted installation. For custom mounting consult factory.

FEATURES

- Available In Made To Measure Lengths Accurate Up To 1/16"
- Patterns Available (See Page 2)
- Damp Location Rated
- CRI 90+ Standard; R9>50
- 5 Year, 50,000 Hour Fixture Warranty
- 2700K, 3000K, 3500K, 4000K & 5000K Color Temperatures Available
- Available with PoE

APPLICATIONS Offices, Lobbies, Retail Stores, Classrooms, Reception Areas & Corridors

CONSTRUCTION Extruded Aluminum Housing with Die Cast Ends. Formed Steel Gear Tray

OPTICS Extruded High Transmission Satin Acrylic Lens with No LED Imaging. Additional Optics Available

WARRANTY 5 Year Limited Warranty (Covers Standard Components)

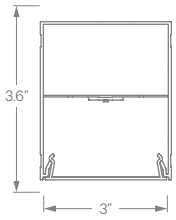
FINISH Standard Powder-Coated White. Custom RAL Colors Available

FIXTURE RATINGS & CERTIFICATIONS Union Made · Made In The USA · DLC Listed* · ETL Listed · Damp Location
*Not all outputs listed, consult factory
*Must Specify JA8 Compliant Driver

ELECTRICAL Integral Driver with 0-10V Dimming Standard. Several Driver Options Available

DRIVERS & SENSORS
For Wiring Diagrams and Sensor Information Click Here

EXTRUSION DIMENSIONS



LED SYSTEM INFORMATION

	Nominal System Watts	Nominal Delivered Lumens	Nominal Efficacy
Standard (LTG1)	7.25 W/ft	560 lm/ft	80 LPW
Low (LTG2)	5 W/ft	405 lm/ft	80 LPW
High (LTG3)	10 W/ft	770 lm/ft	78 LPW

Based on a 3500K luminaire using one driver. Custom outputs available; specify below.

ORDERING

1	2	3	4	5	6	7	8	9	10	11

1 - FIXTURE ID
LS3 LED

2 - LENGTH
2 - 2 ft
4 - 4 ft
8 - 8 ft
X'-X" - Specify Length
PAT - Pattern (Consult Factory)

3 - COLOR TEMP
27 - 2700K/90 CRI
30 - 3000K/90 CRI
35 - 3500K/90 CRI
40 - 4000K/90 CRI
50 - 5000K/90 CRI
TW* - Tunable White
RGBW** - RGB+3000K
*Must use DMX or TW10 Driver
**Must use DMX Driver

4 - LED SYSTEM
LTG1 - Standard
LTG2 - Low
LTG3 - High
LTGC - Custom Output

5 - VOLTAGE
UNV - Universal (120/277V)

6 - DRIVER
DB - Standard Dimming (0-10V)
DB1% - 1% Dimming (0-10V)
DB.1% - 0.1% Dimming (0-10V)
LTEA - Lutron 2-wire 1% Dimming (120V only)
LDE1 - Lutron Digital EcoSystem
LDE5 - 5 Series EcoSystem; 5% Dimming
JA8 - JA8 Compliant 1% Dimming (0-10V)
PoE - Power over Ethernet. Consult Factory for Compatibility
DMX - For Color Tuning and RGBW (Remote)
TW10 - Dual Channel, 0-10V For Color Tuning (CCT and Intensity Control)

7 - FINISH
W - White (Standard)
BLK* - Black
CC* - Custom Color (provide RAL number**)
CWF* - Custom Wood Finish (provide color**)
*White cord and canopy provided. Must specify for other requests.
**(See here for finish options)

8 - MOUNTING
AC - Air Craft Cable (50")
SM - Surface Mount
WM - Wall Mount
*For Perimeter Mount see LS3 spec sheet.

9 - OPTICS
SD - Standard Diffuser
POL - 1" Drop Below Pop Out Lens
ASYM - Asymmetric Optic
WW - Wall Wash Reflector

10 - CONTROL (Optional)
EIS - Enlighted Sensor
WISD - Wattstopper Daylight Sensor
WISM - Wattstopper Occupancy Sensor
SLS - SensiLUM Sensor
ACS - Acuity Controls nLight System
CCS - Casambi Compatible
ECS - Eaton WaveLinx System
*For other control systems not listed consult factory.

11 - CIRCUITS
EM 120V - Emergency Pack
EM 277V - Emergency Pack
EMCKT - Emergency Circuit

Updated: 12/13/2019

CORONET, Inc.
55 Shepherds Lane
Totowa, NJ 07512

T 973 345 7660
F 973 345 8705

CORONET, Inc. reserves the right to make any design changes for continuous improvement which will not affect the overall appearance or performance.

WWW.CORONETLED.COM

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Coronet

LS3 LED

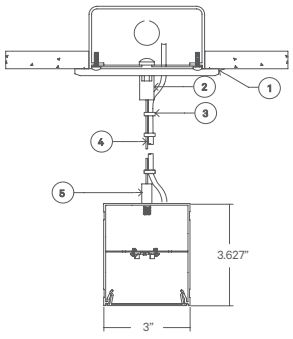
DATE | PROJECT | FIRM | TYPE

Type:

AL05

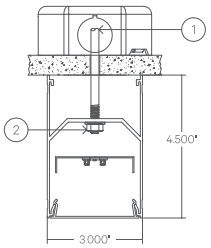
MOUNTING OPTIONS

AC - Air Craft Cable (50")



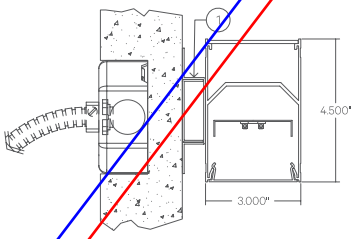
1 - 5" Round Canopy (Standard White Finish)
2 - Canopy Retainer
3 - SJT Cord (Standard White)
4 - Air Craft Cable
5 - Gripper

SM - Surface Mount



1 - Threaded Rod (not supplied)
2 - 1/4-20 Nut (not supplied)

WM - Wall Mount



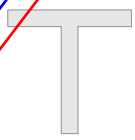
1 - 0.75" Wall Mount Bracket

PATTERNS

Patterns feature illuminated corners and angles. **Must consult factory for custom corners, patterns and elevations.**

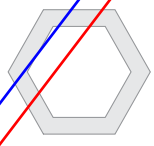
Square Patterns

X Patterns

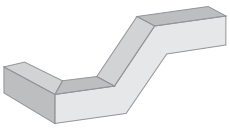


T Patterns

Custom Angles

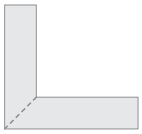


Custom Patterns



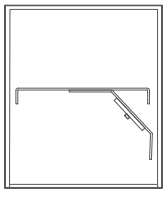
Custom Elevations

LENS CUT



Mitered

WALL WASH REFLECTOR



Cross Section

Updated: 12/13/2019

CORONET, Inc.
55 Shepherds Lane
Totowa, NJ 07512

T 973 345 7660
F 973 345 8705

CORONET, Inc. reserves the right to make any design changes for continuous improvement which will not affect the overall appearance or performance.

WWW.CORONETLED.COM

2/2

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page Remove page

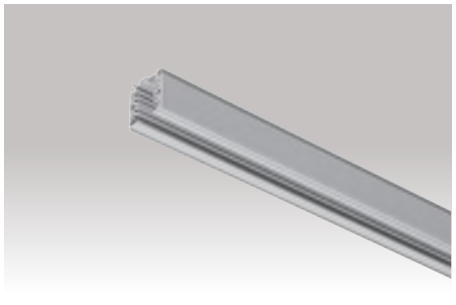
Manufacturer: iGuzzini : Track
Description: 2 Circuit Surface Mounted Track

Fixture Wattage: NA
Lumen Output: NA
Lamp CRI: 80+
Lighting Controls: 0-10V Dimming

Voltage: 120 V
Fixture Finish: White
Lamp CCT: 3000K
Assembly Code: I.016x

2 CIRCUIT TRACK

SPECIFICATION SHEET PAGE: 1 OF 3
Project name:
Type:



General information

Mounting: Surface mount or suspended.

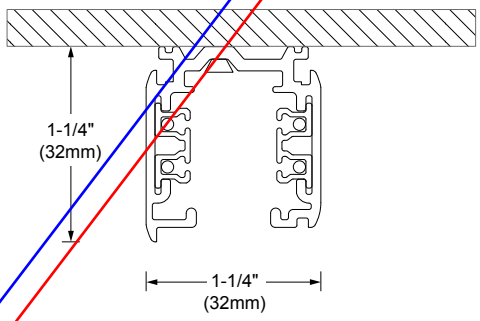
Body: Extruded aluminum professional track.

Electrical: 120V or 277V with two circuits, 20A per circuit. 2 hot, 2 neutral. Line voltage dimming capability.

Finish:
Track: Anodized natural aluminum, white or black painted.
Accessories: White, black or gray painted.

Warranty: 1 year limited warranty.

Certification: cULus listed for dry location.



SECTION VIEW

Type:

AT01

Page 1 of 3

Lighting Notes:

1. Finish to be confirmed by architect
2. Provide with all feed, coupler, joiner accessories to provide track in continuous length and configuration as indicated in the architectural drawings.
3. Track for mounting of trackhead type ATH1 fixtures.

DUE TO CONTINUOUS IMPROVEMENTS, THE INFORMATION HEREIN MAY BE CHANGED WITHOUT NOTICE.

LAST UPDATE: JULY 09, 2018 JP - R7

iGuzzini NORTH AMERICA

c UL us

9320 Boul. St-Laurent, suite 100, Montréal (Québec) Canada H2N 1N7
P.: 514.523.1339 F.: 514.525.6107 www.iguzzini-na.com

ARUP
Project Number: 271565
Phone: 1 212 896 3000

2 CIRCUIT TRACK

SPECIFICATION SHEET PAGE: 2 OF 3

Project name:

Type:

Type:

AT01

Page 2 of 3

ELECTRICAL COMPONENTS
(TO BE ORDERED SEPARATELY)

Feedable connexions

◯ 120V ◯ 277V

◯ 01 - White ◯ 02 - Black ◯ 10 - Gray

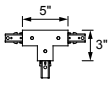
◯ **I.0175 -** Live end feed

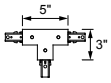
◯ **I.0176 -** Live end feed mirror

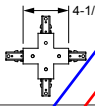
◯ **I.0177 -** Linear coupler

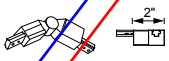
◯ **I.0178 -** Direct coupler

◯ **I.0179 -** L-Connector adjustable polarity

◯ **I.0180 -** T-Connector right polarity 

◯ **I.0181 -** T-Connector left polarity 

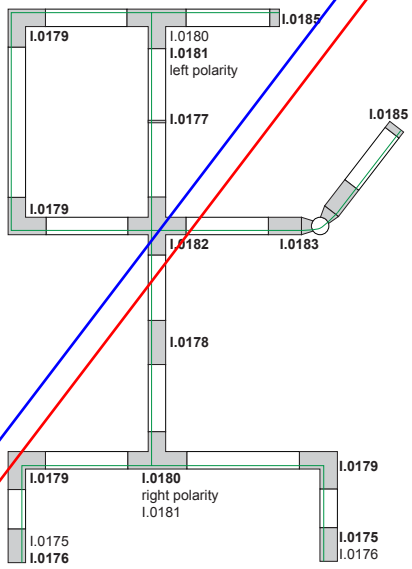
◯ **I.0182 -** X-Connector 

◯ **I.0183 -** Adjustable connector 

◯ **I.0184 -** Outlet box cover

◯ **I.0185 -** End cap

Example of configuration



Track is polarized and is manufactured with identifying ridge (green line on diagrams). Refer to these diagrams to ensure proper connector selection.

DUE TO CONTINUOUS IMPROVEMENTS, THE INFORMATION HEREIN MAY BE CHANGED WITHOUT NOTICE.

LAST UPDATE: JULY 09, 2018 JP - R7

iGuzzini NORTH AMERICA

c UL us

9320 Boul. St-Laurent, suite 100, Montréal (Québec) Canada H2N 1N7
P.: 514.523.1339 F.: 514.525.6107 www.iguzzini-na.com

ARUP
Project Number: 271565
Phone: 1 212 896 3000

2 CIRCUIT TRACK

SPECIFICATION SHEET PAGE: 3 OF 3

Project name:

Type:

Type:

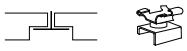
AT01

Page 3 of 3

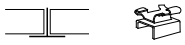
SURFACE MOUNTING (TO BE ORDERED SEPARATELY)

Track mounting clip ◯ 01 - White ◯ 02 - Black

◯ **I.0201 -** For T-BAR 15/16"
Recommanded for Tegular edge tile



◯ **I.0202 -** For T-BAR 15/16"
Recommanded for Square edge tile



◯ **I.0205 -** For dry wall or threaded rod ¼"-20
(Rod supplied by others)

ACCESSORIES (TO BE ORDERED SEPARATELY)

◯ **I.0186 -** Conductor bending tool
(required during field length cutting)

Cover ◯ 01 - White ◯ 02 - Black ◯ 10 - Gray

◯ **I.0191 -** Plastic cover to hide track mounting clip when using stem, cable or rod.

SUSPENSION MOUNTING (TO BE ORDERED SEPARATELY)

Painted finish ◯ 01 - White[1] ◯ 02 - Black[1] ◯ 10 - Gray[1] ◯ 21 - Black/White[2] ◯ 20 - Gray/White[2]

Stem kit

◯ **I.0208-12 -** 12" stem
◯ **I.0208-18 -** 18" stem
◯ **I.0208-24 -** 24" stem
◯ **I.0208-48 -** 48" stem
Includes canopy, stem, 5'5" power cable and track mounting clip

◯ **I.0204-12 -** 12" stem
◯ **I.0204-18 -** 18" stem
◯ **I.0204-24 -** 24" stem
◯ **I.0204-48 -** 48" stem
Includes GWB anchor, stem and track mounting clip

Aircraft cable kit

◯ **I.0216 -** Canopy kit
Includes canopy, 5'-5" aircraft cable, 5'-5" power cable and 6" stem with track mounting clip

◯ **I.0212 -** Anchor kit
Includes GWB anchor, 5'-5" aircraft cable and 6" stem with track mounting clip

Canopy

◯ **I.0220 -** Canopy with 5'-5" power cable

[1] Canopy or anchor will match the kit color
[2] Kit includes a default white painted canopy or anchor

ORDERING INFO RESET INFO

____ - ____ - ____
MODEL VOLTAGE FINISH

MODEL	VOLTAGE	FINISH
◯ **I.0166** - 4'L	◯ **120** - 120V	◯ **01** - White
◯ **I.0167** - 8'L	◯ **277** - 277V	◯ **02** - Black
◯ **I.0168** - 12'L		◯ **12** - Aluminum

DUE TO CONTINUOUS IMPROVEMENTS, THE INFORMATION HEREIN MAY BE CHANGED WITHOUT NOTICE.

LAST UPDATE: JULY 09, 2018 JP - R7

iGuzzini NORTH AMERICA

c UL us

9320 Boul. St-Laurent, suite 100, Montréal (Québec) Canada H2N 1N7
P.: 514.523.1339 F.: 514.525.6107 www.iguzzini-na.com

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page Remove page

Manufacturer: iGuzzini : Adjustable Track Light
Description: Adjustable Track Light

Fixture Wattage: 28 W
Lumen Output: 2010 lumen
Lamp CRI: 90+
Lighting Controls: 0-10V Dimming

Voltage: 120 V
Fixture Finish: White
Lamp CCT: 3000K
Assembly Code: I.PLC S-930-WF-120-X-X

PALCO SMALL

LED

Type: **SPECIFICATION SHEET**
Project :

Palco, a veritable family of projectors, considers the work exhibited not only as a physical element, but also its content, the feelings and the message that it is communicating, without forgetting about the space and its contribution to the work. Its shape is inspired by the brush, the main tool used by the artist in the creative process.

Luminaire characteristic:	**Power input:** 7.5 or 29W **Lumens:** from 235 to 2010lm (for 3000K, 90CRI) **Luminaire efficacy:** Up to 69lm/W
Source:	White LED (LM-80 tested) 3000K : 90CRI, 4000K : 80CRI.
Lumen maintenance:	80% of initial lumens at 50 000 hours (L80).
Optic:	Super Spot, Spot, Medium, Flood, Wide Flood or Wall Washer optics.
Material:	Optical body and arm: Die-cast aluminum Accessory holder ring and driver housing: thermoplastic Reflector: formed aluminum (all optics except Super Spot) Lens: methacrylate (only for Super Spot optic) Protective screen: glass.
Mounting:	Track adaptor with circuit selector for two circuit tracks. Also, compatible with TEK or HTEK from Nordic Aluminum.
Electrical:	Integral high efficiency driver 120 / 277V
Dimming:	Leading (Triac) and trailing edge (ELV) for 120V only.
Finish:	White RAL9010, Black.
Weight:	STANDARD: 2.8lbs (1.3kg) WALL WASHER: 3.2lbs (1.4kg)
Warranty:	5 year limited warranty.
Ratings:	IP20
Certification:	cULus listed for dry location.

JP - R7 Last update: February 2020

Due to continuous improvements, the information herein may be changed without notice

9320 Boul. St-Laurent, suite 100, Montréal (Québec) Canada H2N 1N7, P.: 514.523.1339 F.: 514.525.6107 www.iguzzini-na.com

Type:

ATH1

Lighting Notes:

1. Finish to be confirmed by architect.
2. Provide hex louvers for 10% of fixtures
3. Provide additional spot and medium reflectors for 5% of fixtures respectively.
4. Contractor to coordinate with Architect and Lighting Consultant for final aiming and focus for adjustable fixtures.
5. Track fixture for mounting to type AT01 track.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page Remove page

PALCO
SMALL LED

Type:
Project :

SPECIFICATION SHEET
Page: 2 of 4

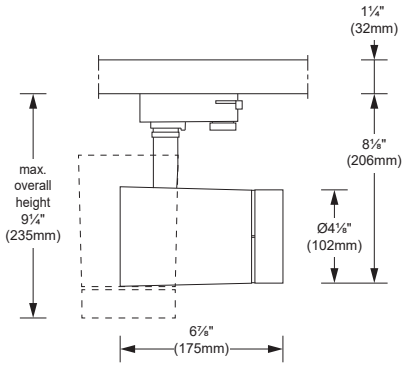
Type:

ATH1

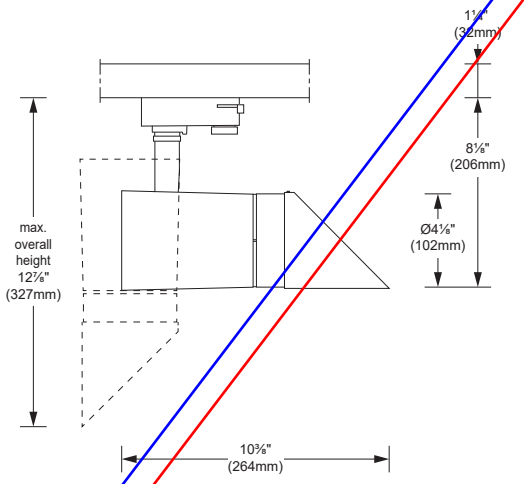
Page 2 of 4

DIMENSION

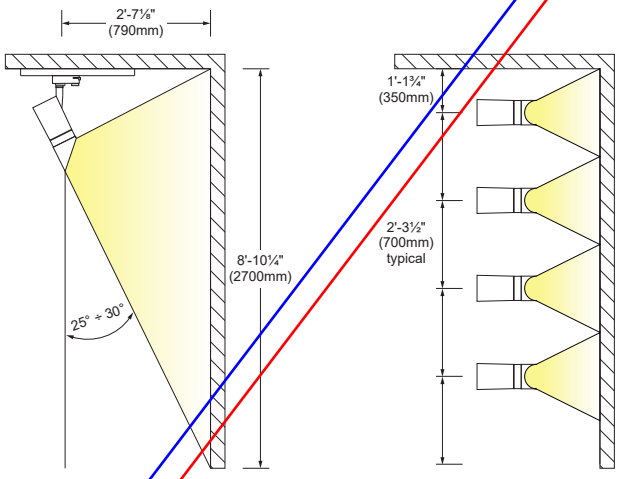
STANDARD
Super Spot, Spot, Medium, Flood and Wide Flood optics



WALL WASHER



WALL WASHER SUGGESTED SPACING AND WALL DISTANCE



SIDE VIEW **TOP VIEW**

JP - R7 Last update: February 28, 2020

Due to continuous improvements, the information herein may be changed without notice

9320 Boul. St-Laurent, suite 100, Montréal (Québec) Canada H2N 1N7, P.: 514.523.1339 F.: 514.525.6107 www.iguzzini-na.com

ARUP
Project Number: 271565
Phone: 1 212 896 3000

PALCO
SMALL LED

Type:
Project :

SPECIFICATION SHEET
Page: 3 of 4

Type:

ATH1

Page 3 of 4

PHOTOMETRIC DATA

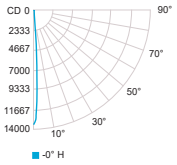
Visit iguzzini.com/us for complete photometric data.

CCT (K)	CRI	LOAD (W)	OPTIC	LUMENS (lm)	EFFICACY (lm / w)	MAX CANDELA (cd)
3000K	90	7.5W	Super Spot(1)	235	31	13 495
		29W	Spot	1960	68	20 965
			Medium	1955	67	11 300
			Flood	1895	65	5 285
			Wide Flood	2010	69	3 830
			Wall Washer	1010	35	1 555

***Use multiplier table for other cct and cri output data**
(1)Not applicable for Super Spot model

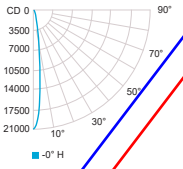
CCT options	4000K
CRI options	80CRI
Multiplier	**1.13**

Super Spot 6° (7.5W - 3000K - 90 CRI)



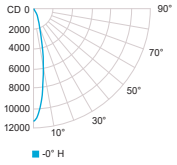
	Center Beam fc	Beam Width ft
2ft	3374	0.2
4ft	843	0.4
6ft	375	0.7
8ft	211	0.9
10ft	135	1.1
12ft	93.7	1.3

Spot 12° (29W - 3000K - 90 CRI)



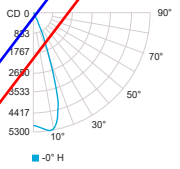
	Center Beam fc	Beam Width ft
2ft	5242	0.4
4ft	1310	0.9
6ft	582	1.3
8ft	328	1.8
10ft	210	2.2
12ft	146	2.7

Medium 20° (29W - 3000K - 90 CRI)



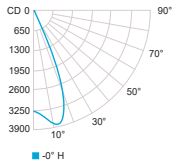
	Center Beam fc	Beam Width ft
2ft	2826	0.7
4ft	707	1.4
6ft	314	2.1
8ft	177	2.8
10ft	113	3.5
12ft	78.5	4.2

Flood 38° (29W - 3000K - 90 CRI)



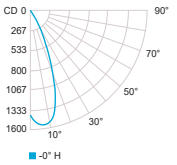
	Center Beam fc	Beam Width ft
2ft	1252	1.3
4ft	313	2.7
6ft	139	4.0
8ft	78.3	5.3
10ft	50.1	6.6
12ft	34.8	8.0

Wide Flood 46° (29W - 3000K - 90 CRI)



	Center Beam fc	Beam Width ft
2ft	826	1.5
4ft	206	3.0
6ft	91.8	4.5
8ft	51.6	6.0
10ft	33	7.5
12ft	22.9	9.0

Wall Washer (29W - 3000K - 90 CRI)



Remove page

Remove page

PALCO
SMALL LED

Type:
Project :

SPECIFICATION SHEET
Page: 4 of 4

Type:

ATH1

Page 4 of 4

ORDERING INFO

I.PLC S - - - - -
FIXTURE

RESET

MODEL

■ **I.PLC S** - Small

LED

☐ **840** - 4000K, 80 CRI ☐ **930** - 3000K, 90 CRI

OPTIC

☐ **SS** - Super Spot(1) ☐ **SP** - Spot ☐ **MD** - Medium ☐ **FL** - Flood
☐ **WF** - Wide Flood ☐ **WW** - Wall Washer

VOLTAGE

☐ **120** - 120V ☐ **277** - 277V

FINISH

☐ **01** - White ☐ **02** - Black

DIMMING

☐ **LTE** - Leading and Trailing edge dimming (120V only)

(1) Only available with 3000K, 90CRI LED **(930)**

ACCESSORIES (TO BE ORDERED SEPARATELY)
for installation consult the instruction sheet

INTERCHANGEABLE REFLECTORS

☐ **I.MXW5-12** - Spot ☐ **I.MXW6-12** - Medium ☐ **I.MXW7-12** - Flood ☐ **I.MXW8-12** - Wide Flood

LENS (Maximum 1 per fixture)

☐ **I.MXD8-24** - Soft focus lens

☐ **I.MXB7-24** - Medium elliptical lens
☐ **I.MXC0-24** - Large elliptical lens
☐ **I.MY34-24** - Opti beam elliptical lens(1)

OPTICAL ACCESSORIES

☐ **I.MXF0-02** - Louvre (black)(2)
☐ **I.MY90-02** - Opti beam louvre (black)

☐ **I.MXF3-01** - Antiglare screen (white)(3)
☐ **I.MXF3-02** - Antiglare screen (black)(3)

☐ **I.MXF6-02** - Directional flaps (black)

(1) Only available for **Super Spot (SS)**.
(2) Must be used with **I.MXD8** lens.
(3) Only available for **Super Spot (SS)** and **Spot (SP)** optics and **I.MXD8** must be used with **Spot (SP)** optic assembly.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Manufacturer: BEGA : 22248
Description: Recessed Wall Light

Fixture Wattage: 3.9 W
Lumen Output: 159 lumen
Lamp CRI: 80+
Lighting Controls: 0-10V Dimming

Voltage: 120 V
Fixture Finish: Dark Grey
Lamp CCT: 2700K
Assembly Code: 22248-K3

LED recessed wall - shielded

BEGA

Type:

AW02

Application
Designed for low mounting heights for interior and exterior locations, the shielded light distribution is ideal for the glare-free illumination of ground surfaces, building entrances, stairs, and footpaths.

Materials
Luminaire housing and faceplate constructed of die-cast marine grade, copper free (≤0.3% copper content) A360.0 aluminum alloy
White safety glass
High temperature silicone gasket
Mechanically captive stainless steel fasteners

NRTL listed to North American Standards, suitable for wet locations
Protection class IP65
Weight: 2.2 lbs

Electrical

Operating voltage	120-277V AC
Minimum start temperature	-30° C
LED module wattage	3.9 W
System wattage	6.0 W
Controllability	0-10V dimmable
Color rendering index	Ra > 90
Luminaire lumens	159 lumens (3000K)
Lifetime at Ta = 15° C	>500,000 h (L70)
Lifetime at Ta = 45° C	172,000 h (L70)

LED color temperature

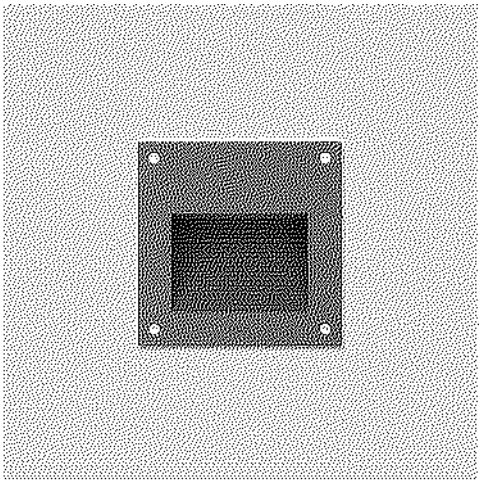
☐ 4000K - Product number + **K4**
☐ 3500K - Product number + **K35**
☒ 3000K - Product number + **K3 (*EXPRESS*)**
☐ 2700K - Product number + **K27**
☐ Amber - Product number + **AMB**

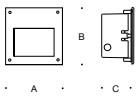
BEGA can supply you with suitable LED replacement modules for up to 20 years after the purchase of LED luminaires - see website for details

Finish
All BEGA standard finishes are matte, textured polyester powder coat with minimum 3 mil thickness.

Available colors ☐ Black (BLK) ☐ White (WHT) ☒ RAL:
☐ Bronze (BRZ) ☐ Silver (SLV) ☐ CUS:

Type:
BEGA Product:
Project:
Modified:





LED recessed wall · shielded

		LED	A	B	C
22272	ADA	3.9W	5 7/8	5 7/8	4 1/8

BEGA 1000 BEGA Way, Carpinteria, CA 93013 (805) 684-0533 info@bega-us.com

Due to the dynamic nature of lighting products and the associated technologies, luminaire data on this sheet is subject to change at the discretion of BEGA North America. For the most current technical data, please refer to bega-us.com
© copyright BEGA 2018
Updated 12/13/19

Lighting Notes:

1. Finish to be confirmed by architect.
2. Coordinate mounting height above grade with architectural drawings. Fixture to be at least 3ft AFFL to avoid being covered in snow during winter.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Manufacturer: iGuzzini : Palco In Out
Description: Surface Mounted Spotlight (Low Voltage)

Fixture Wattage: 16 W
Lumen Output: 1806 lumen
Lamp CRI: 90+
Lighting Controls: 0-10V Dimming

Voltage: 48 V
Fixture Finish: Grey
Lamp CCT: 2700K
Assembly Code: Q719

Type:
AWS03

Palco InOut

Design Artec3 Studio iGuzzini

Last information update: October 2020

Product configuration: Q719
Q719: Spotlight with base - Warm White Led - Class III - Very Wide Flood optic

Product code
Q719: Spotlight with base - Warm White Led - Class III - Very Wide Flood optic

Technical description
Spotlight designed to use LED lamps and a Very Wide Flood optic. The optical assembly and base is made of EN1706AC 46100LF aluminium alloy and subjected to a multi-step, pre-treatment process, in which the main phases are degreasing, fluorozirconation (a protective surface film) and sealing (with a nano-structured silane layer). The following painting stage consists of a primer and a liquid acrylic paint, cured at 150°C, with a high level of weather and UV ray resistance. 5 mm thick tempered sodium-calcium closing glass. Double adjustability allows a 360° rotation about the vertical axis and 90° tilting relative to the horizontal plane. Mechanical aiming locks for rotation on both the vertical axis and horizontal plane. Complete with a monochrome LED circuit and an Opti Beam Reflector optic system. The product includes a PG13.5 cable gland. Black rubber outlet cable complete with anti-transpiration device. Black rubber outlet cable complete with anti-transpiration device. Electronic ballast to be ordered separately. Option of using optic accessories assembled via an accessory holder frame. All external screws used are made of AISI stainless steel.

Installation
Floor, wall, ceiling or ground-installed via a stake.

Colour
White (01) | Grey (15)

Weight (Kg)
1.3

Mounting
wall surface|ground spike

Wiring
The product is supplied with a black rubber outlet cable complete with anti-transpiration device L=1000mm.

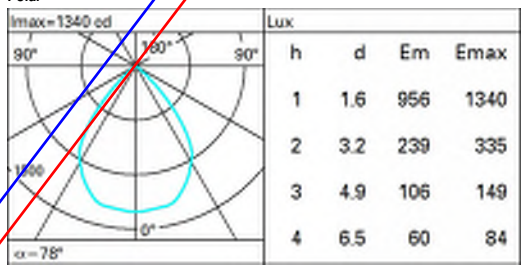
Complies with EN60598-1 and pertinent regulations

IK07 IP66

Technical data

lm system:	1806	MacAdam Step:	2
W system:	16	Life Time LED 1:	100,000h - L80 - B10 (Ta 25°C)
lm source:	2150	Ballast losses [W]:	0
W source:	16	Lamp code:	LED
Luminous efficiency (lm/W, real value):	112.9	Number of lamps for optical assembly:	1
lm in emergency mode:	-	ZVEI Code:	LED
Total light flux at or above an angle of 90° [Lm]:	0	Number of optical assemblies:	1
Light Output Ratio (L.O.R.) [%]:	84	Ambient operating temperature range:	from -30°C to 35°C.
Beam angle [°]:	78°	Lifetime of product at ambient operating temperature:	≥ 50.000h Ta=25°C
CRI:	80		
Colour temperature [K]:	3000	LED Currente:	470

Polar



Lighting Notes:

1. Finish to be confirmed by architect.
2. Contractor to coordinate mounting with Architect.
3. Contractor to coordinate with Architect and Lighting Consultant for final aiming and focus for adjustable fixtures.
4. Contractor to coordinate location for remote driver in nearest weather proof location.

Q719_EN 1 / 2

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Isolux

UGR diagram

Corrected UGR values (at 2750 lm bare lamp luminous flux)

Reflect.: ceil/cav		0.70	0.70	0.50	0.50	0.30	0.70	0.70	0.50	0.50	0.30
walls		0.50	0.30	0.50	0.30	0.30	0.50	0.30	0.50	0.30	0.30
work pl.		0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Room dim.				viewed crosswise					viewed endwise		
x	y										
2H	2H	28.1	28.9	28.4	27.1	27.3	28.1	28.9	28.4	27.1	27.3
	3H	28.0	28.6	28.3	26.9	27.2	28.0	28.6	28.3	26.9	27.2
	4H	25.9	28.5	28.2	26.8	27.1	25.9	28.5	28.2	26.8	27.1
	6H	25.8	28.4	28.2	26.7	27.0	25.8	28.4	28.2	26.7	27.0
	8H	25.8	28.3	28.2	26.7	27.0	25.8	28.3	28.2	26.7	27.0
	12H	25.8	28.3	28.1	26.6	27.0	25.8	28.3	28.1	26.6	27.0
4H	2H	25.9	28.5	28.2	26.8	27.1	25.9	28.5	28.2	26.8	27.1
	3H	25.8	28.3	28.1	26.6	27.0	25.8	28.3	28.1	26.6	27.0
	4H	25.7	28.1	28.1	26.5	26.9	25.7	28.1	28.1	26.5	26.8
	6H	25.6	28.0	28.0	26.4	26.8	25.6	28.0	28.0	26.4	26.8
	8H	25.5	25.9	28.0	26.3	26.7	25.5	25.9	28.0	26.3	26.7
	12H	25.5	25.8	25.9	26.2	26.7	25.5	25.8	25.9	26.2	26.7
6H	4H	25.5	25.9	28.0	26.3	26.7	25.5	25.9	28.0	26.3	26.7
	6H	25.4	25.7	25.9	26.2	26.7	25.4	25.7	25.9	26.2	26.7
	8H	25.4	25.6	25.9	26.1	26.6	25.4	25.6	25.9	26.1	26.6
	12H	25.3	25.6	25.8	26.0	26.6	25.3	25.6	25.8	26.0	26.6
12H	4H	25.5	25.8	25.9	26.2	26.7	25.5	25.8	25.9	26.2	26.7
	6H	25.4	25.6	25.9	26.1	26.6	25.4	25.6	25.9	26.1	26.6
	8H	25.3	25.6	25.8	26.0	26.6	25.3	25.6	25.8	26.0	26.6

Variations with the observer position at spacing:

S =	1.0H	3.2 / -16.6	3.2 / -16.6
	1.5H	5.5 / -23.3	5.5 / -23.3
	2.0H	7.5 / -25.3	7.5 / -25.3

Type:

AWS03

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Manufacturer: iGuzzini : Palco In Out
Description: Tree Mounted Spotlight (Low Voltage)

Fixture Wattage: 16 W
Lumen Output: 1806 lumen
Lamp CRI: 80+
Lighting Controls: 0-10V Dimming

Voltage: 48 V
Fixture Finish: Grey
Lamp CCT: 2700K
Assembly Code: Q719 + Tree Mounting Accessories

Palco InOut

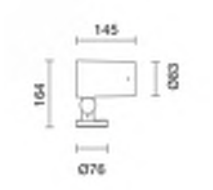
Design Artec3 Studio iGuzzini

Last information update: October 2020

Product configuration: Q719
Q719: Spotlight with base - Warm White Led - Class III - Very Wide Flood optic

Product code
Q719: Spotlight with base - Warm White Led - Class III - Very Wide Flood optic

Technical description
Spotlight designed to use LED lamps and a Very Wide Flood optic. The optical assembly and base is made of EN1706AC 46100LF aluminium alloy and subjected to a multi-step, pre-treatment process, in which the main phases are degreasing, fluorozirconation (a protective surface film) and sealing (with a nano-structured silane layer). The following painting stage consists of a primer and a liquid acrylic paint, cured at 150°C, with a high level of weather and UV ray resistance. 5 mm thick tempered sodium-calcium closing glass. Double adjustability allows a 360° rotation about the vertical axis and 90° tilting relative to the horizontal plane. Mechanical aiming locks for rotation on both the vertical axis and horizontal plane. Complete with a monochrome LED circuit and an Opti Beam Reflector optic system. The product includes a PG13.5 cable gland. Black rubber outlet cable complete with anti-transpiration device. Black rubber outlet cable complete with anti-transpiration device. Electronic ballast to be ordered separately. Option of using optic accessories assembled via an accessory holder frame. All external screws used are made of A2 stainless steel.



Installation
Floor, wall, ceiling or ground-installed via a stake.

Colour
White (01) | Grey (15)

Weight (Kg)
1.3

Mounting
wall surface|ground spike

Wiring
The product is supplied with a black rubber outlet cable complete with anti-transpiration device L=1000mm.

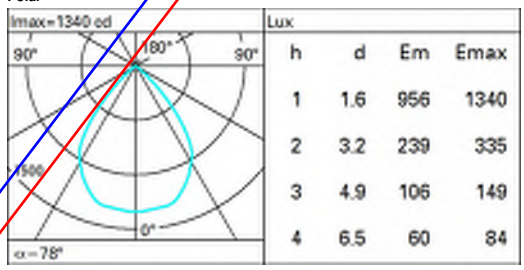
Complies with EN60598-1 and pertinent regulations

IK07 IP66

Technical data

lm system:	1806	MacAdam Step:	2
W system:	16	Life Time LED 1:	100,000h - L80 - B10 (Ta 25°C)
lm source:	2150	Ballast losses [W]:	0
W source:	16	Lamp code:	LED
Luminous efficiency (lm/W, real value):	112.9	Number of lamps for optical assembly:	1
lm in emergency mode:	-	ZVEI Code:	LED
Total light flux at or above an angle of 90° [Lm]:	0	Number of optical assemblies:	1
Light Output Ratio (L.O.R.) [%]:	84	Ambient operating temperature range:	from -30°C to 35°C.
Beam angle [°]:	78°	Lifetime of product at ambient operating temperature:	≥ 50.000h Ta=25°C
CRI:	80		
Colour temperature [K]:	3000	LED Currente:	470

Polar



Q719_EN 1 / 2

Type:

AS01

Page 1 of 2

Lighting Notes:

1. Include adjustable tree strap.
2. Fixture finish to be confirmed by Landscape Architect.
3. Contractor to coordinate mounting with Landscape Architect.
4. Contractor to coordinate with Landscape Architect and Lighting Consultant for final aiming and focus for adjustable fixtures.
5. Contractor to coordinate location for remote driver in nearest weather proof location.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page

Remove page

Isolux

UGR diagram

Corrected UGR values (at 2750 lm lamp luminous flux)

Reflect.: ceil/cav	0.70	0.70	0.50	0.50	0.30	0.70	0.70	0.50	0.50	0.30
walls	0.50	0.30	0.50	0.30	0.30	0.50	0.30	0.50	0.30	0.30
work pl.	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Room dim. x	y	viewed crosswise					viewed endwise			
2H	2H	28.1	28.9	28.4	27.1	27.3	28.1	28.9	28.4	27.1	27.3
	3H	28.0	28.6	28.3	28.9	27.2	28.0	28.6	28.3	28.9	27.2
	4H	25.9	28.5	28.2	28.8	27.1	25.9	28.5	28.2	28.8	27.1
	6H	25.8	28.4	28.2	28.7	27.0	25.8	28.4	28.2	28.7	27.0
	8H	25.8	28.3	28.2	28.7	27.0	25.8	28.3	28.2	28.7	27.0
	12H	25.8	28.3	28.1	28.6	27.0	25.8	28.3	28.1	28.8	27.0
4H	2H	25.9	28.5	28.2	28.8	27.1	25.9	28.5	28.2	28.8	27.1
	3H	25.8	28.3	28.1	28.8	27.0	25.8	28.3	28.1	28.8	27.0
	4H	25.7	28.1	28.1	28.5	26.9	25.7	28.1	28.1	28.5	26.9
	6H	25.6	28.0	28.0	28.4	26.8	25.6	28.0	28.0	28.4	26.8
	8H	25.5	25.9	28.0	28.3	26.7	25.5	25.9	28.0	28.3	26.7
	12H	25.5	25.8	25.9	28.2	26.7	25.5	25.8	25.9	28.2	26.7
6H	4H	25.5	25.9	28.0	28.3	26.7	25.5	25.9	28.0	28.3	26.7
	6H	25.4	25.7	25.9	28.2	26.7	25.4	25.7	25.9	28.2	26.7
	8H	25.4	25.6	25.9	28.1	26.6	25.4	25.6	25.9	28.1	26.6
	12H	25.3	25.6	25.8	28.0	26.6	25.3	25.6	25.8	28.0	26.6
12H	4H	25.5	25.8	25.9	28.2	26.7	25.5	25.8	25.9	28.2	26.7
	6H	25.4	25.6	25.9	28.1	26.6	25.4	25.6	25.9	28.1	26.6
	8H	25.3	25.6	25.8	28.0	26.6	25.3	25.6	25.8	28.0	26.6

Variations with the observer position at spacing:

S =	1.0H	3.2 / -18.6	3.2 / -20.6
	1.5H	5.5 / -23.3	5.5 / -23.3
	2.0H	7.5 / -25.3	7.5 / -25.3

Type:

AS01

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:

Conservation Building

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Manufacturer: LITHONIA LIGHTING : ZL1N
Description: Surface Mounted Linear

Fixture Wattage: 68 W
Lumen Output: 7470 lumen
Lamp CRI: 90+
Lighting Controls: 0-10V Dimming

Voltage: 120 V
Fixture Finish: Anodized Aluminum
Lamp CCT: 4000K
Assembly Code: ZL1N-L96-SMR-10000LM-SBL FST-120-40K-90CRI

LITHONIA LIGHTING®

FEATURES & SPECIFICATIONS

INTENDED USE — Built on the compact, low-profile Z strip channel, this LED strip offers long maintenance-free life, several color temperatures, lumen outputs and lengths. Ideal for new construction and retrofit applications in T5 and T8 lengths. Ideal for uplight and downlight in commercial, retail, manufacturing, warehouse, cove and display applications. **Certain airborne contaminants can diminish the integrity of acrylic and/or polycarbonate.** Click here for Acrylic-Polycarbonate Compatibility table for suitable uses.

CONSTRUCTION — Compact-design channel and cover are formed from code-gauge cold-rolled steel. Easy to install row aligner included for continuous row mounting.

Finish: Paint options include high-gloss, baked white enamel (WH), galvanized (GALV), matte black (MB) and smoke gray (SKGY). After fabrication, five-stage iron phosphate pre-treatment ensures superior paint adhesion and rust resistance.

OPTICS — Standard diffuse snap on/snap off lens eliminates pixels, improves uniformity and minimizes glare. L/LENS option available.

ELECTRICAL — L70>60,000hours. Utilizes high-output LEDs integrated on a two-layer circuit board, ensuring cool-running operation. Optional internal pluggable wiring harness for reduced labor cost in row mounting applications. (See PLR_ ordering information on page 3.) Electronic LED driver is rated for 75 input watts maximum (see Operational Data on page two for actual wattage consumption), **multi-volt input and 0-10V dimming standard**. This fixture is designed to withstand a maximum line surge of 2.5kV at 0.75kA combination wave for indoor locations, for applications requiring higher level of protection additional surge protection must be provided.

LEDs provide nominal 80 CRI at 3000 K, 3500 K,4000 K, or 5000 K.

Lumen output up to 2,000 lumens per foot. In 86°F (30°C) ambient environments. Luminaire should be installed in applications where ambient temperatures do not exceed 86°F (30°C).

INSTALLATION — Tool-less channel cover for easy installation.

Fixture may be surface mounted (with or without ZSPRG hanger), pendant or stem mounted with appropriate mounting options. Three-point aligner locks in place for easy continuous row mounting.

LISTINGS — CSA certified to US and Canadian safety standards. For use in damp locations between -40°F (-40°C) and 86°F (30°C).

DesignLights Consortium® (DLC) qualified product. Not all versions of this product may be DLC qualified. Please check the DLC Qualified Products List at www.designlights.org to confirm which versions are qualified.

WARRANTY — 5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/support/customer-support/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application.

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

Catalog Number	
Notes	
Type	

Z SERIES

LED Striplight

ZL1N

24", 48" and 96" Lengths

L/Lens

Lensed

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® or XPoint™ Wireless control networks marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

Type:

AL01

Page 1 of 6

Lighting Notes:

1. Mounting to be coordinated with architect.
2. Mounting and installation of conduit and routing path to be coordinated with architect.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:

AL01

ZL1N LED Striplight

A+ Capable options indicated by this color background.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: ZL1N L48 3000LM FST MVOLT 40K 80CRI WH

Series		Length		Reflectors[2]		Nominal lumens[3]		Diffuser		Voltage	
ZL1N	LED striplight	L24	24"[1]	(blank)	Less reflector	1500LM	1,500 lumens	FST	Snap on frosted, diffuse	MVOLT	120-277V
				SMR	Symmetric	2500LM	2,500 lumens	L/LENS	No diffuser	120	120V
						3500LM	3,500 lumens	SBL FST	Straight blade louver with snap on frosted, diffuse	208	208V
		L46	46"	(blank)	Less reflector	3000LM	3,000 lumens			240	240V
		L48	48"	ASR	Asymmetric (L48 only)	5000LM	5,000 lumens			277	277V
				SMR	Symmetric	7000LM	7,000 lumens			347	347V[4]
TZL1N	LED striplight	L92	92"	(blank)	Less reflector	6000LM	6,000 lumens			480	480V[4]
		L96	96"	SMR	Symmetric	10000LM	10,000 lumens				
						14000LM	14,000 lumens				

Color temperature		Color rendering index		Options			Paint finish	
30K	3000 K	80CRI	80 CRI	PLR___	Plug-in wiring[5,6]	**Individual Controls**[5]	WH	White
35K	3500 K	90CRI	90 CRI	PLR1LVG	Plug-in wiring-low voltage[5,6]	LBOZU 360° low mount motion sensor, pre-wired[10]	GALV	Galvanized
40K	4000 K			E7W	Emergency battery pack, 7W CA Title 20 Noncompliant[7]	LBH0SZU 360° low mount motion sensor with dimming, pre-wired[10]	MB	Matte black
50K	5000 K			2E7W	Two Emergency battery packs, 7W CA Title 20 Noncompliant[7,8]	LBPZU 360° low mount motion sensor with photocell, pre-wired[10]	SKGY	Smoke gray
				E10WLCP	Emergency battery pack, 10W Linear Constant Power, Certified in CA Title 20 MAEDBS[7]	LBM0SZU 360° low mount motion sensor, dimming & switching photocell, pre-wired[10]		
				2E10WLCP	Two Emergency battery packs, 10W Linear Constant Power, Certified in CA Title 20 MAEDBS[7,8]	**Cord sets:**[11]		
				E15WLCP	Emergency battery pack, 15W Linear Constant Power, Certified in CA Title 20 MAEDBS[7,8]	CS1W Straight plug, 120V		
				OUTEND	Cord set to exit endplate of fixture	CS3W Twist-lock, 120V		
				Wireless Controls[5]		CS7W Straight plug, 277V		
				NLTAIR2 RLSXR10	nLight Air Generation 2 Fixture mount, LSXR sensor low mount 360˚	CS11W Twist-lock, 277V		
				NLTAIR2 RLSXR10EM	nLight Air Generation 2 Fixture mount, LSXR sensor low mount 360˚, UL924 Emergency operation[9]	CS25W Twist-lock, 347V		
						CS97W Twist-lock, 480V		
						CS93W 600V SEOOW white cord, no plug (no voltage required)		

Accessories: *Order as separate catalog number.*

HC36	Hanger chain, 36"	ZLR L24 SYM WH	24" symmetric reflector, white finish
ZACVH	Aircraft cable 10' (one pair)	ZLR L46 SYM UPL WH	46" symmetric reflector with uplight, white finish
ZLANGBKT	Luma-tilt™ angle bracket for shelf or ledge mounting only	ZLR L46 SYM WH	46" symmetric reflector, white finish
SQ_	Stem kit, 2" increments up to 48"	ZLR L48 ASY WH	48" asymmetric reflector, white finish
NPP16D	nLight® switching/dimming module	ZLR L48 SYM UPL WH	48" symmetric reflector with uplight, white finish
rPP20D	nLight® Air switching/dimming module	ZLR L48 SYM WH	48" symmetric reflector, white finish
LSXR	Sensor Switch® LSXR occupancy sensor[4]	ZLR L92 SYM UPL WH	92" symmetric reflector with uplight, white finish
ZSPRG	For 15/16" T-grid only	ZLR L92 SYM WH	92" symmetric reflector, white finish
WGZ24	24" wireguard, white[12]	ZLR L96 SYM UPL WH	96" symmetric reflector with uplight, white finish
WGZ48	48" wireguard, white[12,13]	ZLR L96 SYM WH	96" symmetric reflector, white finish
ZLR L24 SYM UPL WH	24" symmetric reflector with uplight, white finish	UNIVERSAL REFL ALIGNER	Universal reflector aligners, quantity 1

Notes

1. Not available with 347V, 480V or Batteries
2. Optional. Reflectors ship separately.
3. See Operational Data on page 2 for actual lumens.
4. Utilizes step down transformer.
5. See ordering information on pages 4 and 5 and rLSXR specification sheet for more configurations. When choosing Sensor and PLR for same fixture, consult the factory.
6. Not available with cord sets.
7. MVOLT only. Not available with cord sets with plugs. Battery Spec sheet linked for more information.
8. Only available with 10,000LM and 14,000LM packages.
9. MVOLT only.
10. Available with MVOLT, 347V and 480V only. This sensor configuration is suitable for minimum ambient temperature of 14°F (-10°C). See page 6 for low temperature option providing -4°F (-20°C) minimum ambient Sensors come prewired, they must be snapped into place at time of installation.
11. Cordsets exit back of fixture unless OUTEND option is specified. Must specify voltage (not required when ordering CS93W).
12. Not compatible with reflector
13. Order 2 for tandem double length fixtures (TZL1N).

ARUP
Project Number: 271565
Phone: 1 212 896 3000

ZL1N LED Striplight

Type:

AL01

OPERATIONAL DATA

	Nominal lumen package	Length (inches)	Delivered Lumens 3000 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 3500 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 4000 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 5000 K CCT @ 77°F (25°C) ambient temperature		Wattage @ 120V/277V	Comparable Light Source
			80 CRI	90 CRI	80 CRI	90 CRI	80 CRI	90 CRI	80 CRI	90 CRI		
Lensed	1500LM	24	1738	1409	1777	1467	1804	1494	1871	1528	15	1-lamp 17W T8
	2500LM	24	2265	1846	2315	1900	2351	1947	2438	1991	19	1-lamp 17W T8
	3500LM	24	3586	2924	3666	3026	3723	3084	3860	3152	31	1-lamp 32W T8, 1-lamp 54W T5H0, 50W HID
	3000LM	46 or 48	3172	2586	3243	2677	3293	2728	3415	2788	25	1-lamp 32W T8, 1-lamp 54W T5H0, 50W HID
	5000LM	46 or 48	4417	3601	4515	3727	4585	3798	4754	3882	34	2-lamp 32W T8, 1-lamp 54W T5H0, 70W HID
	7000LM	46 or 48	6535	5328	6681	5515	6785	5619	7035	5744	52	3-lamp 32W T8, 2-lamp 54W T5H0, 100W HID
	6000LM	92 or 96	6561	5349	6708	5537	6812	5642	7063	5767	48	3-lamp 32W T8, 2-lamp 54W T5H0, 100W HID
	10000LM	92 or 96	8687	7082	8881	7331	9019	7470	9351	7636	68	4-lamp 32W T8, 2-lamp 54W T5H0, 100W HID
	14000LM	92 or 96	12457	10513	12735	10665	12933	10711	13409	10949	104	4-lamp 32W T8, 3-lamp 54W T5H0, 150W HID
Unlensed	1500LM	24	1881	1534	1923	1588	1953	1618	2025	1654	15	1-lamp 17W T8
	2500LM	24	2452	1999	2506	2069	2545	2108	2639	2155	19	1-lamp 17W T8
	3500LM	24	3882	3165	3969	3276	4031	3338	4179	3412	31	1-lamp 32W T8, 1-lamp 54W T5H0, 50W HID
	3000LM	46 or 48	3434	2800	3511	2898	3565	2953	3697	3019	25	1-lamp 32W T8, 1-lamp 54W T5H0, 50W HID
	5000LM	46 or 48	4781	3898	4888	4035	4964	4111	5147	4203	34	2-lamp 32W T8, 1-lamp 54W T5H0, 70W HID
	7000LM	46 or 48	7075	5768	7233	5971	7345	6083	7616	6219	52	3-lamp 32W T8, 2-lamp 54W T5H0, 100W HID
	6000LM	92 or 96	7103	5791	7261	5995	7374	6108	7646	6243	48	3-lamp 32W T8, 2-lamp 54W T5H0, 100W HID
	10000LM	92 or 96	9404	7667	9614	7937	9764	8087	10123	8266	68	4-lamp 32W T8, 2-lamp 54W T5H0, 100W HID
	14000LM	92 or 96	13485	10994	13786	11381	14001	11596	14516	11853	104	4-lamp 32W T8, 3-lamp 54W T5H0, 150W HID

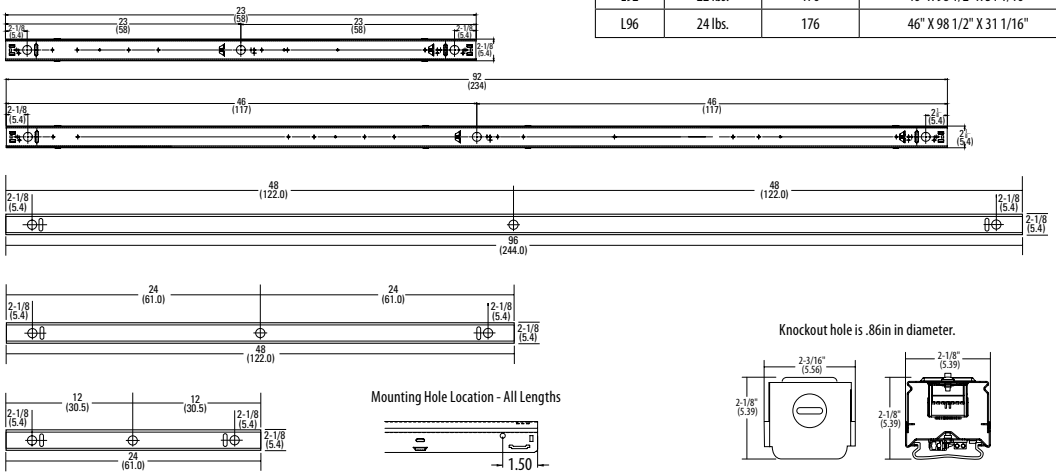
DIMENSIONS

All dimensions are shown in inches (centimeters) unless otherwise noted.

Specifications subject to change without notice.

PALLET DIMENSIONS

Length	Approximate weight	Fixtures per pallet	Approximate pallet dimensions (L x W x H)
L24	7 lbs.	408	46" X 51" X 32 11/16"
L46	11 lbs.	176	46" X 51" X 32 1/16"
L48	12 lbs.	176	46" X 51" X 31 3/8"
L92	22 lbs.	176	46" X 98 1/2" X 31 1/16"
L96	24 lbs.	176	46" X 98 1/2" X 31 1/16"



Mounting Hole Location - All Lengths

Knockout hole is .86in in diameter.

PHOTOMETRICS

Please see www.lithonia.com

ARUP
Project Number: 271565
Phone: 1 212 896 3000

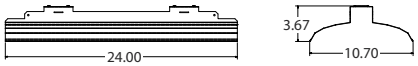
Type:

AL01

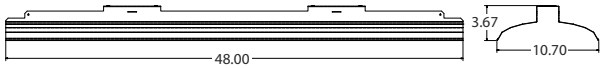
ZL1N LED Striplight

REFLECTORS (Optional)

L24 Reflector



L48 Reflector



L96 Reflector

PHOTOMETRICS

Please see www.lithonia.com

PRODUCT INFORMATION

Advanced plug-in system with two-circuit capability. Available on industrial and strip products and a variety of architectural products mounted in continuous rows. 1, 2, 3 and 4-lamp fixtures. PLR22 (2-circuit) and crossover harness switches hot circuit serving next fixture in row. Reduces fixture types on job for alternating circuit applications (see example below.)

Easy one-step installation, saves up to 35% on labor costs. Expanded switching flexibility helps save energy.

Rows can be 50% longer with two-circuit systems. Polarized, lock-together nylon connectors prevent miswiring in the field. #12 THHN conductor, rated 600V, 90°C. White neutral wire included. Grounding accomplished by fixture in-row connectors.

CSA certified systems available with up to 2 circuits. G ground required.

Note: Specifications subject to change without notice.

Wiring

PLR

Advanced 1 or 2-Circuit Plug-In

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Series	Number of hot wires	Branch circuits		Dimming	Ground
PLR	(blank) Not required for 22	Circuits to which ballast is connected	Emergency circuit connected	LV Low-voltage dimming	G Ground, required
PLR22	1 Black	(blank) Not required for 22 or PLR1	(blank) No emergency circuit		
	2 Black and red	A Black wire	ELA Emergency circuit wired to black wire		
		B Red wire	ELB Emergency circuit wired to red wire		

Typical Applications

- Multiple-circuit and single-circuit for longer continuous rows
- Multiple-circuit with alternating fixtures on separate circuits, 2-circuit (PLR 22)
- Multiple circuit with night-lights located along row as desired

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:

AL01

ZL1N LED Striplight

LSXR – Fixture Mount Occupancy Sensor (see www.AcuityControls.com for additional information)

- Three interchangeable lens options to satisfy multiple mounting heights and coverage pattern requirements.
- Integrated mounting bracket drops lens down 3" from chase nipple.
- Single or dual relay versions — designed with robust protection from the harsh switching requirements of T5 and LED loads.
- Photocell and 0-10VDC dimming options.
- No PIR field calibration or sensitivity adjustments required.
- Sensor ambient temperature rating of 14°F (-10°C) to 131°F (55°C).

LSXR configuration	Comparable CMRB sensor	Old style sensor nomenclature
For shortest lead times use one of the following LSXR configurations		
LC0ZU	CMRB 50	MSI
LCH0SZU	CMRB 50 D	MSID
LCPZU	CMRB 50 P	MSIPED
LA0ZU	CMRB 6	MSI360
LAH0SZU	CMRB 6 D	MSI360D
LAPZU	CMRB 6 P	MSI360PED

SELECTIONS BELOW WILL EXTEND ORDER LEAD TIME. CONSULT YOUR SALES REPRESENTATIVE FOR DETAILS.

SINGLE RELAY

ORDERING INFORMATION — **Example**: LAH0SZU

Series	Lens option	Dimming/Photocell	Max. dim level	Min. dim level	Temp/Humidity	Default occupancy time delay
L LSXR passive infrared indoor occupancy sensor	A High mount, 360° B Low mount, 360° C High mount aisleway	0 None[1] H High/low occupancy operation P Switching photocell (on/off)[1] M Dimming and switching photocell G Dimming and switching photocell with high/low occupancy operation	0 10 VDC 9 9 VDC 8 8 VDC 7 7 VDC	S Minimum dim level of ballast 1 1 VDC 2 2 VDC 3 3 VDC 4 4 VDC 5 5 VDC 6 6 VDC	Z None T Low temperature[2]	I 30 sec D 2.5 min X 5.0 min R 7.5 min U 10.0 min (with minimum 15 minute on time) V 15.0 min W 20.0 min Y 30.0 min

Notes

1 Max and min dim levels not applicable with this option.

2 Ambient temperature rating of -4°F (-20°C) to 131°F (55°C).

DUAL RELAY (Available with 120, 277, and 347V only)

ORDERING INFORMATION — **Example**: LA2KZU

Series	Lens option	Poles	Operating mode	Temp/Humidity	Default occupancy time delay
L LSXR passive infrared indoor occupancy sensor	A High mount, 360° B Low mount, 360° C High mount aisleway	2 Dual relay	J None K Alternating off relays (promotes even lamp wear) O Alternating off relays w/photocell P Switching photocell(on/off) E Photocell on/off (pole 1 only) F Photocell on/off - both poles (dual set-point)	Z None T Low temperature[1]	I 30 sec D 2.5 min X 5.0 min R 7.5 min U 10.0 min (with minimum 15 minute on time) V 15.0 min W 20.0 min Y 30.0 min

Notes

1 Ambient temperature rating of -4°F (-20°C) to 131°F (55°C).

Example: LENS 50 J100

Replacement lenses: *Order as separate catalog number.*

Series	Lens type	Package quantity
LENS	6 High mount 360° 10 Low mount 360° 50 High mount aisleway	[blank] Single Lens J10 10-pack J100 100-pack

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:

AL01

Page 6 of 6

ZL1N LED Striplight

OPTIONS AND ACCESSORIES

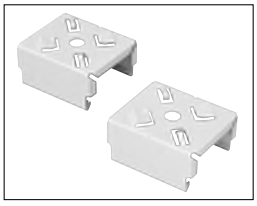
The Z Series fixture offers numerous options for almost every electrical and optical component, including a long list of field-installable accessories.

HANGER CHAIN

36" chain with Y hanger.

Order as:

HC36



Z SPRING HANGER

Snap 'n' lock design requires no fasteners and can be used on T-grid ceiling or universal mounting systems.

Order as:

ZSPRG

ZACVH HANGER

10' Aircraft cable with Y hanger.

Order as:

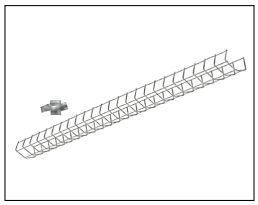
ZACVH

ANGLE MOUNTING BRACKET

Luma-tilt™ angle bracket ships as a pair

Order as:

ZLANGBKT



WIRE GUARD

Order as:

WGZ24

WGZ48

© 2013-2020 Acuity Brands Lighting, Inc. All rights reserved.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Manufacturer: LITHONIA LIGHTING : ZL1N
Description: Surface Mounted Linear

Fixture Wattage:	34 W	**Voltage:**	120 V
Lumen Output:	3798 lumen	**Fixture Finish:**	Anodized Aluminum
Lamp CRI:	90+	**Lamp CCT:**	4000K
Lighting Controls:	0-10V Dimming	**Assembly Code:**	ZL1N-L48-SMR-5000LM-SBL FST-120-40K-90CRI

LITHONIA LIGHTING®

FEATURES & SPECIFICATIONS

INTENDED USE — Built on the compact, low-profile Z strip channel, this LED strip offers long maintenance-free life, several color temperatures, lumen outputs and lengths. Ideal for new construction and retrofit applications in T5 and T8 lengths. Ideal for uplight and downlight in commercial, retail, manufacturing, warehouse, cove and display applications. **Certain airborne contaminants can diminish the integrity of acrylic and/or polycarbonate.** Click here for Acrylic-Polycarbonate Compatibility table for suitable uses.

CONSTRUCTION — Compact-design channel and cover are formed from code-gauge cold-rolled steel. Easy to install row aligner included for continuous row mounting.

Finish: Paint options include high-gloss, baked white enamel (WH), galvanized (GALV), matte black (MB) and smoke gray (SKGY). After fabrication, five-stage iron phosphate pre-treatment ensures superior paint adhesion and rust resistance.

OPTICS — Standard diffuse snap on/snap off lens eliminates pixels, improves uniformity and minimizes glare. L/LENS option available.

ELECTRICAL — L70>60,000hours. Utilizes high-output LEDs integrated on a two-layer circuit board, ensuring cool-running operation. Optional internal pluggable wiring harness for reduced labor cost in row mounting applications. (See PLR_ ordering information on page 3.) Electronic LED driver is rated for 75 input watts maximum (see Operational Data on page two for actual wattage consumption), **multi-volt input and 0-10V dimming standard**. This fixture is designed to withstand a maximum line surge of 2.5kV at 0.75kA combination wave for indoor locations, for applications requiring higher level of protection additional surge protection must be provided.

LEDs provide nominal 80 CRI at 3000 K, 3500 K,4000 K, or 5000 K.

Lumen output up to 2,000 lumens per foot. In 86°F (30°C) ambient environments. Luminaire should be installed in applications where ambient temperatures do not exceed 86°F (30°C).

INSTALLATION — Tool-less channel cover for easy installation.

Fixture may be surface mounted (with or without ZSPRG hanger), pendant or stem mounted with appropriate mounting options. Three-point aligner locks in place for easy continuous row mounting.

LISTINGS — CSA certified to US and Canadian safety standards. For use in damp locations between -40°F (-40°C) and 86°F (30°C).

DesignLights Consortium® (DLC) qualified product. Not all versions of this product may be DLC qualified. Please check the DLC Qualified Products List at www.designlights.org to confirm which versions are qualified.

WARRANTY — 5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/support/customer-support/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application.

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

Catalog Number
Notes
Type

Z SERIES

LED Striplight

ZL1N

24", 48" and 96" Lengths

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® or XPoint™ Wireless control networks marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

Type:
AL01a

Page 1 of 6

Lighting Notes:

1. Mounting to be coordinated with architect.
2. Mounting and installation of conduit and routing path to be coordinated with architect.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:
AL01a
Page 2 of 6

ZL1N LED Striplight

A+ Capable options indicated by this color background.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: ZL1N L48 3000LM FST MVOLT 40K 80CRI WH

Series		Length		Reflectors[2]		Nominal lumens[3]		Diffuser		Voltage	
ZL1N	LED striplight	L24	24"[1]	(blank)	Less reflector	1500LM	1,500 lumens	FST	Snap on frosted, diffuse	MVOLT	120-277V
				SMR	Symmetric	2500LM	2,500 lumens	L/LENS	No diffuser	120	120V
						3500LM	3,500 lumens	SBL FST	Straight blade louver with snap on frosted, diffuse	208	208V
		L46	46"	(blank)	Less reflector	3000LM	3,000 lumens			240	240V
		L48	48"	ASR	Asymmetric (L48 only)	5000LM	5,000 lumens			277	277V
				SMR	Symmetric	7000LM	7,000 lumens			347	347V[4]
TZL1N	LED striplight	L92	92"	(blank)	Less reflector	6000LM	6,000 lumens			480	480V[4]
		L96	96"	SMR	Symmetric	10000LM	10,000 lumens				
						14000LM	14,000 lumens				

Color temperature		Color rendering index		Options			Paint finish	
30K	3000 K	80CRI	80 CRI	PLR___	Plug-in wiring[5,6]	**Individual Controls**[5]	WH	White
35K	3500 K	90CRI	90 CRI	PLR1LVG	Plug-in wiring-low voltage[5,6]	LBOZU 360° low mount motion sensor, pre-wired[10]	GALV	Galvanized
40K	4000 K			E7W	Emergency battery pack, 7W CA Title 20 Noncompliant[7]	LBH0SZU 360° low mount motion sensor with dimming, pre-wired[10]	MB	Matte black
50K	5000 K			2E7W	Two Emergency battery packs, 7W CA Title 20 Noncompliant[7,8]	LBPZU 360° low mount motion sensor with photocell, pre-wired[10]	SKGY	Smoke gray
				E10WLCP	Emergency battery pack, 10W Linear Constant Power, Certified in CA Title 20 MAEDBS[7]	LBM0SZU 360° low mount motion sensor, dimming & switching photocell, pre-wired[10]		
				2E10WLCP	Two Emergency battery packs, 10W Linear Constant Power, Certified in CA Title 20 MAEDBS[7,8]	**Cord sets:**[11]		
				E15WLCP	Emergency battery pack, 15W Linear Constant Power, Certified in CA Title 20 MAEDBS[7,8]	CS1W Straight plug, 120V		
				OUTEND	Cord set to exit endplate of fixture	CS3W Twist-lock, 120V		
				Wireless Controls[5]		CS7W Straight plug, 277V		
				NLTAIR2 RLSXR10	nLight Air Generation 2 Fixture mount, LSXR sensor low mount 360˚	CS11W Twist-lock, 277V		
				NLTAIR2 RLSXR10EM	nLight Air Generation 2 Fixture mount, LSXR sensor low mount 360˚, UL924 Emergency operation[9]	CS25W Twist-lock, 347V		
						CS97W Twist-lock, 480V		
						CS93W 600V SEOOW white cord, no plug (no voltage required)		

Accessories: *Order as separate catalog number.*

HC36	Hanger chain, 36"	ZLR L24 SYM WH	24" symmetric reflector, white finish
ZACVH	Aircraft cable 10' (one pair)	ZLR L46 SYM UPL WH	46" symmetric reflector with uplight, white finish
ZLANGBKT	Luma-tilt™ angle bracket for shelf or ledge mounting only	ZLR L46 SYM WH	46" symmetric reflector, white finish
SQ_	Stem kit, 2" increments up to 48"	ZLR L48 ASY WH	48" asymmetric reflector, white finish
NPP16D	nLight® switching/dimming module	ZLR L48 SYM UPL WH	48" symmetric reflector with uplight, white finish
rPP20D	nLight® Air switching/dimming module	ZLR L48 SYM WH	48" symmetric reflector, white finish
LSXR	Sensor Switch® LSXR occupancy sensor[4]	ZLR L92 SYM UPL WH	92" symmetric reflector with uplight, white finish
ZSPRG	For 15/16" T-grid only	ZLR L92 SYM WH	92" symmetric reflector, white finish
WGZ24	24" wireguard, white[12]	ZLR L96 SYM UPL WH	96" symmetric reflector with uplight, white finish
WGZ48	48" wireguard, white[12,13]	ZLR L96 SYM WH	96" symmetric reflector, white finish
ZLR L24 SYM UPL WH	24" symmetric reflector with uplight, white finish	UNIVERSAL REFL ALIGNER	Universal reflector aligners, quantity 1

Notes

1 Not available with 347V, 480V or Batteries
2 Optional. Reflectors ship separately.
3 See Operational Data on page 2 for actual lumens.
4 Utilizes step down transformer.
5 See ordering information on pages 4 and 5 and rLSXR specification sheet for more configurations. When choosing Sensor and PLR for same fixture, consult the factory.
6 Not available with cord sets.
7 MVOLT only. Not available with cord sets with plugs. Battery Spec sheet linked for more information.
8 Only available with 10,000LM and 14,000LM packages.
9 MVOLT only.
10 Available with MVOLT, 347V and 480V only. This sensor configuration is suitable for minimum ambient temperature of 14°F (-10°C). See page 6 for low temperature option providing -4°F (-20°C) minimum ambient Sensors come prewired, they must be snapped into place at time of installation.
11 Cordsets exit back of fixture unless OUTEND option is specified. Must specify voltage (not required when ordering CS93W).
12 Not compatible with reflector
13 Order 2 for tandem double length fixtures (TZL1N).

ARUP
Project Number: 271565
Phone: 1 212 896 3000

ZL1N LED Striplight

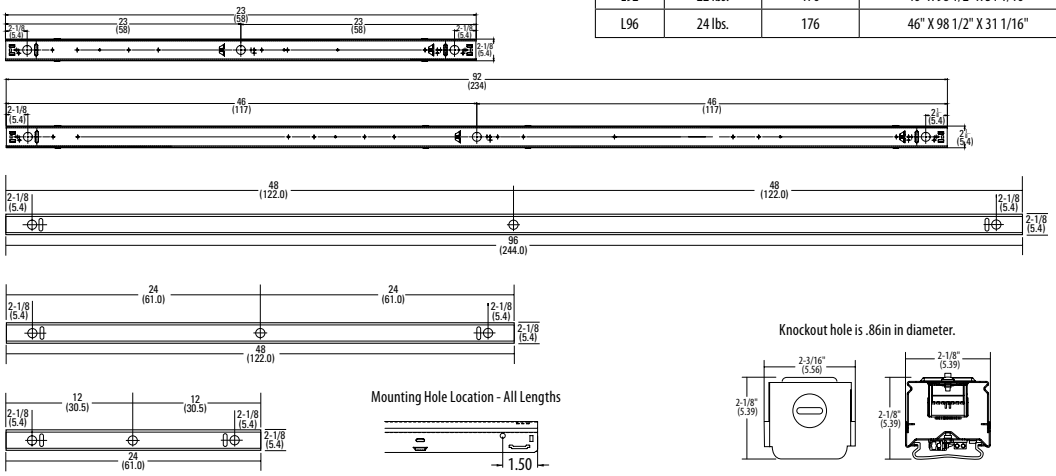
Type:
AL01a
Page 3 of 6

OPERATIONAL DATA												
	Nominal lumen package	Length (inches)	Delivered Lumens 3000 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 3500 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 4000 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 5000 K CCT @ 77°F (25°C) ambient temperature		Wattage @ 120V/277V	Comparable Light Source
			80 CRI	90 CRI	80 CRI	90 CRI	80 CRI	90 CRI	80 CRI	90 CRI		
Lensed	1500LM	24	1738	1409	1777	1467	1804	1494	1871	1528	15	1-lamp 17W T8
	2500LM	24	2265	1846	2315	1900	2351	1947	2438	1991	19	1-lamp 17W T8
	3500LM	24	3586	2924	3666	3026	3723	3084	3860	3152	31	1-lamp 32W T8, 1-lamp 54W T5H0, 50W HID
	3000LM	46 or 48	3172	2586	3243	2677	3293	2728	3415	2788	25	1-lamp 32W T8, 1-lamp 54W T5H0, 50W HID
	5000LM	46 or 48	4417	3601	4515	3727	4585	3798	4754	3882	34	2-lamp 32W T8, 1-lamp 54W T5H0, 70W HID
	7000LM	46 or 48	6535	5328	6681	5515	6785	5619	7035	5744	52	3-lamp 32W T8, 2-lamp 54W T5H0, 100W HID
	6000LM	92 or 96	6561	5349	6708	5537	6812	5642	7063	5767	48	3-lamp 32W T8, 2-lamp 54W T5H0, 100W HID
	10000LM	92 or 96	8687	7082	8881	7331	9019	7470	9351	7636	68	4-lamp 32W T8, 2-lamp 54W T5H0, 100W HID
	14000LM	92 or 96	12457	10513	12735	10665	12933	10711	13409	10949	104	4-lamp 32W T8, 3-lamp 54W T5H0, 150W HID
Unlensed	1500LM	24	1881	1534	1923	1588	1953	1618	2025	1654	15	1-lamp 17W T8
	2500LM	24	2452	1999	2506	2069	2545	2108	2639	2155	19	1-lamp 17W T8
	3500LM	24	3882	3165	3969	3276	4031	3338	4179	3412	31	1-lamp 32W T8, 1-lamp 54W T5H0, 50W HID
	3000LM	46 or 48	3434	2800	3511	2898	3565	2953	3697	3019	25	1-lamp 32W T8, 1-lamp 54W T5H0, 50W HID
	5000LM	46 or 48	4781	3898	4888	4035	4964	4111	5147	4203	34	2-lamp 32W T8, 1-lamp 54W T5H0, 70W HID
	7000LM	46 or 48	7075	5768	7233	5971	7345	6083	7616	6219	52	3-lamp 32W T8, 2-lamp 54W T5H0, 100W HID
	6000LM	92 or 96	7103	5791	7261	5995	7374	6108	7646	6243	48	3-lamp 32W T8, 2-lamp 54W T5H0, 100W HID
	10000LM	92 or 96	9404	7667	9614	7937	9764	8087	10123	8266	68	4-lamp 32W T8, 2-lamp 54W T5H0, 100W HID
	14000LM	92 or 96	13485	10994	13786	11381	14001	11596	14516	11853	104	4-lamp 32W T8, 3-lamp 54W T5H0, 150W HID

DIMENSIONS

All dimensions are shown in inches (centimeters) unless otherwise noted.
Specifications subject to change without notice.

PALLET DIMENSIONS			
Length	Approximate weight	Fixtures per pallet	Approximate pallet dimensions (L x W x H)
L24	7 lbs.	408	46" X 51" X 32 11/16"
L46	11 lbs.	176	46" X 51" X 32 1/16"
L48	12 lbs.	176	46" X 51" X 31 3/8"
L92	22 lbs.	176	46" X 98 1/2" X 31 1/16"
L96	24 lbs.	176	46" X 98 1/2" X 31 1/16"



Mounting Hole Location - All Lengths

Knockout hole is .86in in diameter.

PHOTOMETRICS

Please see www.lithonia.com

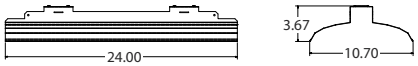
ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:
AL01a
Page 4 of 6

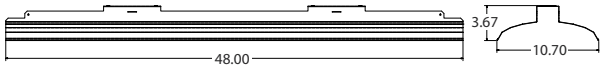
ZL1N LED Striplight

REFLECTORS (Optional)

L24 Reflector



L48 Reflector



L96 Reflector

PHOTOMETRICS

Please see www.lithonia.com

PRODUCT INFORMATION

Advanced plug-in system with two-circuit capability. Available on industrial and strip products and a variety of architectural products mounted in continuous rows. 1, 2, 3 and 4-lamp fixtures. PLR22 (2-circuit) and crossover harness switches hot circuit serving next fixture in row. Reduces fixture types on job for alternating circuit applications (see example below.)

Easy one-step installation, saves up to 35% on labor costs. Expanded switching flexibility helps save energy.

Rows can be 50% longer with two-circuit systems. Polarized, lock-together nylon connectors prevent miswiring in the field. #12 THHN conductor, rated 600V, 90°C. White neutral wire included. Grounding accomplished by fixture in-row connectors.

CSA certified systems available with up to 2 circuits. G ground required.

Note: Specifications subject to change without notice.

Wiring

PLR

Advanced 1 or 2-Circuit Plug-In

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Series	Number of hot wires	Branch circuits		Dimming	Ground
PLR	(blank) Not required for 22	Circuits to which ballast is connected	Emergency circuit connected	LV Low-voltage dimming	G Ground, required
PLR22	1 Black	(blank) Not required for 22 or PLR1	(blank) No emergency circuit		
	2 Black and red	A Black wire	ELA Emergency circuit wired to black wire		
		B Red wire	ELB Emergency circuit wired to red wire		

Typical Applications

- Multiple-circuit and single-circuit for longer continuous rows
- Multiple-circuit with alternating fixtures on separate circuits, 2-circuit (PLR 22)
- Multiple circuit with night-lights located along row as desired

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:
AL01a
Page 5 of 6

ZL1N LED Striplight

LSXR – Fixture Mount Occupancy Sensor (see www.AcuityControls.com for additional information)

- Three interchangeable lens options to satisfy multiple mounting heights and coverage pattern requirements.
- Integrated mounting bracket drops lens down 3" from chase nipple.
- Single or dual relay versions — designed with robust protection from the harsh switching requirements of T5 and LED loads.
- Photocell and 0-10VDC dimming options.
- No PIR field calibration or sensitivity adjustments required.
- Sensor ambient temperature rating of 14°F (-10°C) to 131°F (55°C).

LSXR configuration	Comparable CMRB sensor	Old style sensor nomenclature
For shortest lead times use one of the following LSXR configurations		
LC0ZU	CMRB 50	MSI
LCH0SZU	CMRB 50 D	MSID
LCPZU	CMRB 50 P	MSIPED
LA0ZU	CMRB 6	MSI360
LAH0SZU	CMRB 6 D	MSI360D
LAPZU	CMRB 6 P	MSI360PED

SELECTIONS BELOW WILL EXTEND ORDER LEAD TIME. CONSULT YOUR SALES REPRESENTATIVE FOR DETAILS.

SINGLE RELAY

ORDERING INFORMATION — **Example**: LAH0SZU

Series	Lens option	Dimming/Photocell	Max. dim level	Min. dim level	Temp/Humidity	Default occupancy time delay
L LSXR passive infrared indoor occupancy sensor	A High mount, 360° B Low mount, 360° C High mount aisleway	0 None[1] H High/low occupancy operation P Switching photocell (on/off)[1] M Dimming and switching photocell G Dimming and switching photocell with high/low occupancy operation	0 10 VDC 9 9 VDC 8 8 VDC 7 7 VDC	S Minimum dim level of ballast 1 1 VDC 2 2 VDC 3 3 VDC 4 4 VDC 5 5 VDC 6 6 VDC	Z None T Low temperature[2]	I 30 sec D 2.5 min X 5.0 min R 7.5 min U 10.0 min (with minimum 15 minute on time) V 15.0 min W 20.0 min Y 30.0 min

Notes
1 Max and min dim levels not applicable with this option.
2 Ambient temperature rating of -4°F (-20°C) to 131°F (55°C).

DUAL RELAY (Available with 120, 277, and 347V only)

ORDERING INFORMATION — **Example**: LA2KZU

Series	Lens option	Poles	Operating mode	Temp/Humidity	Default occupancy time delay
L LSXR passive infrared indoor occupancy sensor	A High mount, 360° B Low mount, 360° C High mount aisleway	2 Dual relay	J None K Alternating off relays (promotes even lamp wear) O Alternating off relays w/photocell P Switching photocell(on/off) E Photocell on/off (pole 1 only) F Photocell on/off - both poles (dual set-point)	Z None T Low temperature[1]	I 30 sec D 2.5 min X 5.0 min R 7.5 min U 10.0 min (with minimum 15 minute on time) V 15.0 min W 20.0 min Y 30.0 min

Notes
1 Ambient temperature rating of -4°F (-20°C) to 131°F (55°C).

Example: LENS 50 J100

Replacement lenses: *Order as separate catalog number.*

Series	Lens type	Package quantity
LENS	6 High mount 360° 10 Low mount 360° 50 High mount aisleway	[blank] Single Lens J10 10-pack J100 100-pack

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:
AL01a
Page 6 of 6

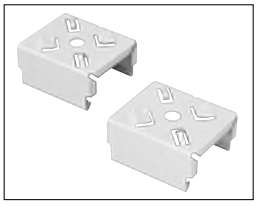
ZL1N LED Striplight

OPTIONS AND ACCESSORIES

The Z Series fixture offers numerous options for almost every electrical and optical component, including a long list of field-installable accessories.

HANGER CHAIN
36" chain with Y hanger.

Order as:
HC36



Z SPRING HANGER
Snap 'n' lock design requires no fasteners and can be used on T-grid ceiling or universal mounting systems.

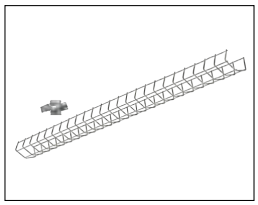
Order as:
ZSPRG

ZACVH HANGER
10' Aircraft cable with Y hanger.

Order as:
ZACVH

ANGLE MOUNTING BRACKET
Luma-tilt™ angle bracket ships as a pair

Order as:
ZLANGBKT



WIRE GUARD

Order as:
WGZ24
WGZ48

© 2013-2020 Acuity Brands Lighting, Inc. All rights reserved.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Manufacturer: LITHONIA LIGHTING : ZL1N
Description: Surface Mounted Linear

Fixture Wattage:	104 W	**Voltage:**	120 V
Lumen Output:	10711 lumen	**Fixture Finish:**	Anodized Aluminum
Lamp CRI:	90+	**Lamp CCT:**	4000K
Lighting Controls:	0-10V Dimming	**Assembly Code:**	ZL1N-L48-SMR-7000LM-SBL FST-120-40K-90CRI

LITHONIA LIGHTING®

FEATURES & SPECIFICATIONS

INTENDED USE — Built on the compact, low-profile Z strip channel, this LED strip offers long maintenance-free life, several color temperatures, lumen outputs and lengths. Ideal for new construction and retrofit applications in T5 and T8 lengths. Ideal for uplight and downlight in commercial, retail, manufacturing, warehouse, cove and display applications. **Certain airborne contaminants can diminish the integrity of acrylic and/or polycarbonate.** Click here for Acrylic-Polycarbonate Compatibility table for suitable uses.

CONSTRUCTION — Compact-design channel and cover are formed from code-gauge cold-rolled steel. Easy to install row aligner included for continuous row mounting.

Finish: Paint options include high-gloss, baked white enamel (WH), galvanized (GALV), matte black (MB) and smoke gray (SKGY). After fabrication, five-stage iron phosphate pre-treatment ensures superior paint adhesion and rust resistance.

OPTICS — Standard diffuse snap on/snap off lens eliminates pixels, improves uniformity and minimizes glare. L/LENS option available.

ELECTRICAL — L70>60,000hours. Utilizes high-output LEDs integrated on a two-layer circuit board, ensuring cool-running operation. Optional internal pluggable wiring harness for reduced labor cost in row mounting applications. (See PLR_ ordering information on page 3.) Electronic LED driver is rated for 75 input watts maximum (see Operational Data on page two for actual wattage consumption), **multi-volt input and 0-10V dimming standard**. This fixture is designed to withstand a maximum line surge of 2.5kV at 0.75kA combination wave for indoor locations, for applications requiring higher level of protection additional surge protection must be provided.

LEDs provide nominal 80 CRI at 3000 K, 3500 K,4000 K, or 5000 K.

Lumen output up to 2,000 lumens per foot. In 86°F (30°C) ambient environments. Luminaire should be installed in applications where ambient temperatures do not exceed 86°F (30°C).

INSTALLATION — Tool-less channel cover for easy installation.

Fixture may be surface mounted (with or without ZSPRG hanger), pendant or stem mounted with appropriate mounting options. Three-point aligner locks in place for easy continuous row mounting.

LISTINGS — CSA certified to US and Canadian safety standards. For use in damp locations between -40°F (-40°C) and 86°F (30°C).

DesignLights Consortium® (DLC) qualified product. Not all versions of this product may be DLC qualified. Please check the DLC Qualified Products List at www.designlights.org to confirm which versions are qualified.

WARRANTY — 5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/support/customer-support/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application.

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

Catalog Number	
Notes	
Type	

Z SERIES

LED Striplight

ZL1N

24", 48" and 96" Lengths

L/Lens

Lensed

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® or XPoint™ Wireless control networks marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

INDUSTRIAL

ZL1N
Page 1 of 6

Type:
AL01b

Page 1 of 6

Lighting Notes:

1. Mounting to be coordinated with architect.
2. Mounting and installation of conduit and routing path to be coordinated with architect.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:
AL01b
Page 2 of 6

ZL1N LED Striplight

A+ Capable options indicated by this color background.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: ZL1N L48 3000LM FST MVOLT 40K 80CRI WH

Series		Length		Reflectors[2]		Nominal lumens[3]		Diffuser		Voltage	
ZL1N	LED striplight	L24	24"[1]	(blank)	Less reflector	1500LM	1,500 lumens	FST	Snap on frosted, diffuse	MVOLT	120-277V
				SMR	Symmetric	2500LM	2,500 lumens	L/LENS	No diffuser	120	120V
						3500LM	3,500 lumens	SBL FST	Straight blade louver with snap on frosted, diffuse	208	208V
		L46	46"	(blank)	Less reflector	3000LM	3,000 lumens			240	240V
		L48	48"	ASR	Asymmetric (L48 only)	5000LM	5,000 lumens			277	277V
				SMR	Symmetric	7000LM	7,000 lumens			347	347V[4]
TZL1N	LED striplight	L92	92"	(blank)	Less reflector	6000LM	6,000 lumens			480	480V[4]
		L96	96"	SMR	Symmetric	10000LM	10,000 lumens				
						14000LM	14,000 lumens				

Color temperature		Color rendering index		Options			Paint finish	
30K	3000 K	80CRI	80 CRI	PLR___	Plug-in wiring[5,6]	**Individual Controls**[5]	WH	White
35K	3500 K	90CRI	90 CRI	PLR1LVG	Plug-in wiring-low voltage[5,6]	LBOZU 360° low mount motion sensor, pre-wired[10]	GALV	Galvanized
40K	4000 K			E7W	Emergency battery pack, 7W CA Title 20 Noncompliant[7]	LBH0SZU 360° low mount motion sensor with dimming, pre-wired[10]	MB	Matte black
50K	5000 K			2E7W	Two Emergency battery packs, 7W CA Title 20 Noncompliant[7,8]	LBPZU 360° low mount motion sensor with photocell, pre-wired[10]	SKGY	Smoke gray
				E10WLCP	Emergency battery pack, 10W Linear Constant Power, Certified in CA Title 20 MAEDBS[7]	LBM0SZU 360° low mount motion sensor, dimming & switching photocell, pre-wired[10]		
				2E10WLCP	Two Emergency battery packs, 10W Linear Constant Power, Certified in CA Title 20 MAEDBS[7,8]	**Cord sets:**[11]		
				E15WLCP	Emergency battery pack, 15W Linear Constant Power, Certified in CA Title 20 MAEDBS[7,8]	CS1W Straight plug, 120V		
				OUTEND	Cord set to exit endplate of fixture	CS3W Twist-lock, 120V		
				Wireless Controls[5]		CS7W Straight plug, 277V		
				NLTAIR2 RLSXR10	nLight Air Generation 2 Fixture mount, LSXR sensor low mount 360˚	CS11W Twist-lock, 277V		
				NLTAIR2 RLSXR10EM	nLight Air Generation 2 Fixture mount, LSXR sensor low mount 360˚, UL924 Emergency operation[9]	CS25W Twist-lock, 347V		
						CS97W Twist-lock, 480V		
						CS93W 600V SEOOW white cord, no plug (no voltage required)		

Accessories: *Order as separate catalog number.*

HC36	Hanger chain, 36"	ZLR L24 SYM WH	24" symmetric reflector, white finish
ZACVH	Aircraft cable 10' (one pair)	ZLR L46 SYM UPL WH	46" symmetric reflector with uplight, white finish
ZLANGBKT	Luma-tilt™ angle bracket for shelf or ledge mounting only	ZLR L46 SYM WH	46" symmetric reflector, white finish
SQ_	Stem kit, 2" increments up to 48"	ZLR L48 ASY WH	48" asymmetric reflector, white finish
NPP16D	nLight® switching/dimming module	ZLR L48 SYM UPL WH	48" symmetric reflector with uplight, white finish
rPP20D	nLight® Air switching/dimming module	ZLR L48 SYM WH	48" symmetric reflector, white finish
LSXR	Sensor Switch® LSXR occupancy sensor[4]	ZLR L92 SYM UPL WH	92" symmetric reflector with uplight, white finish
ZSPRG	For 15/16" T-grid only	ZLR L92 SYM WH	92" symmetric reflector, white finish
WGZ24	24" wireguard, white[12]	ZLR L96 SYM UPL WH	96" symmetric reflector with uplight, white finish
WGZ48	48" wireguard, white[12,13]	ZLR L96 SYM WH	96" symmetric reflector, white finish
ZLR L24 SYM UPL WH	24" symmetric reflector with uplight, white finish	UNIVERSAL REFL ALIGNER	Universal reflector aligners, quantity 1

Notes

1. Not available with 347V, 480V or Batteries
2. Optional. Reflectors ship separately.
3. See Operational Data on page 2 for actual lumens.
4. Utilizes step down transformer.
5. See ordering information on pages 4 and 5 and rLSXR specification sheet for more configurations. When choosing Sensor and PLR for same fixture, consult the factory.
6. Not available with cord sets.
7. MVOLT only. Not available with cord sets with plugs. Battery Spec sheet linked for more information.
8. Only available with 10,000LM and 14,000LM packages.
9. MVOLT only.
10. Available with MVOLT, 347V and 480V only. This sensor configuration is suitable for minimum ambient temperature of 14°F (-10°C). See page 6 for low temperature option providing -4°F (-20°C) minimum ambient Sensors come prewired, they must be snapped into place at time of installation.
11. Cordsets exit back of fixture unless OUTEND option is specified. Must specify voltage (not required when ordering CS93W).
12. Not compatible with reflector
13. Order 2 for tandem double length fixtures (TZL1N).

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:
AL01b
Page 3 of 6

ZL1N LED Striplight

OPERATIONAL DATA

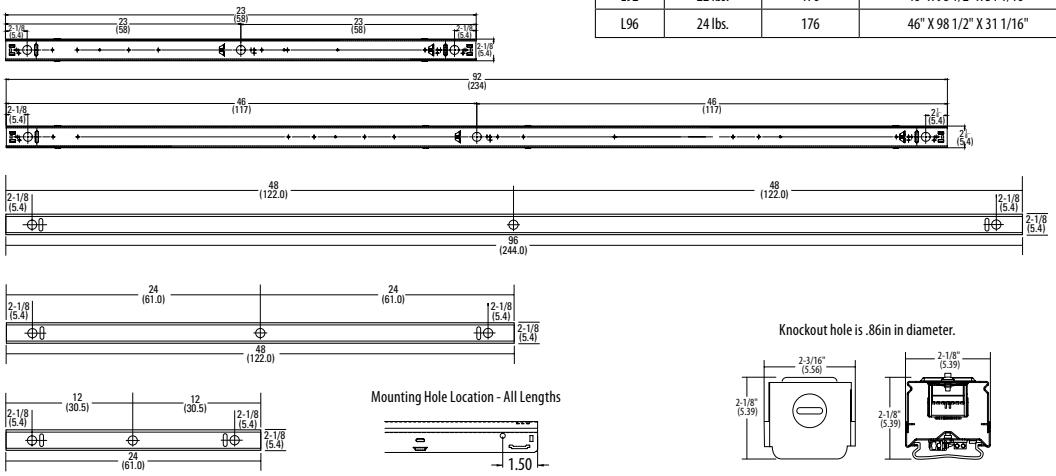
	Nominal lumen package	Length (inches)	Delivered Lumens 3000 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 3500 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 4000 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 5000 K CCT @ 77°F (25°C) ambient temperature		Wattage @ 120V/277V	Comparable Light Source
			80 CRI	90 CRI	80 CRI	90 CRI	80 CRI	90 CRI	80 CRI	90 CRI		
Lensed	1500LM	24	1738	1409	1777	1467	1804	1494	1871	1528	15	1-lamp 17W T8
	2500LM	24	2265	1846	2315	1900	2351	1947	2438	1991	19	1-lamp 17W T8
	3500LM	24	3586	2924	3666	3026	3723	3084	3860	3152	31	1-lamp 32W T8, 1-lamp 54W T5HO, 50W HID
	3000LM	46 or 48	3172	2586	3243	2677	3293	2728	3415	2788	25	1-lamp 32W T8, 1-lamp 54W T5HO, 50W HID
	5000LM	46 or 48	4417	3601	4515	3727	4585	3798	4754	3882	34	2-lamp 32W T8, 1-lamp 54W T5HO, 70W HID
	7000LM	46 or 48	6535	5328	6681	5515	6785	5619	7035	5744	52	3-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	6000LM	92 or 96	6561	5349	6708	5537	6812	5642	7063	5767	48	3-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	10000LM	92 or 96	8687	7082	8881	7331	9019	7470	9351	7636	68	4-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	14000LM	92 or 96	12457	10513	12735	10665	12933	10711	13409	10949	104	4-lamp 32W T8, 3-lamp 54W T5HO, 150W HID
Unlensed	1500LM	24	1881	1534	1923	1588	1953	1618	2025	1654	15	1-lamp 17W T8
	2500LM	24	2452	1999	2506	2069	2545	2108	2639	2155	19	1-lamp 17W T8
	3500LM	24	3882	3165	3969	3276	4031	3338	4179	3412	31	1-lamp 32W T8, 1-lamp 54W T5HO, 50W HID
	3000LM	46 or 48	3434	2800	3511	2898	3565	2953	3697	3019	25	1-lamp 32W T8, 1-lamp 54W T5HO, 50W HID
	5000LM	46 or 48	4781	3898	4888	4035	4964	4111	5147	4203	34	2-lamp 32W T8, 1-lamp 54W T5HO, 70W HID
	7000LM	46 or 48	7075	5768	7233	5971	7345	6083	7616	6219	52	3-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	6000LM	92 or 96	7103	5791	7261	5995	7374	6108	7646	6243	48	3-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	10000LM	92 or 96	9404	7667	9614	7937	9764	8087	10123	8266	68	4-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	14000LM	92 or 96	13485	10994	13786	11381	14001	11596	14516	11853	104	4-lamp 32W T8, 3-lamp 54W T5HO, 150W HID

DIMENSIONS

All dimensions are shown in inches (centimeters) unless otherwise noted.
Specifications subject to change without notice.

PALLET DIMENSIONS

Length	Approximate weight	Fixtures per pallet	Approximate pallet dimensions (L x W x H)
L24	7 lbs.	408	46" X 51" X 32 11/16"
L46	11 lbs.	176	46" X 51" X 32 1/16"
L48	12 lbs.	176	46" X 51" X 31 3/8"
L92	22 lbs.	176	46" X 98 1/2" X 31 1/16"
L96	24 lbs.	176	46" X 98 1/2" X 31 1/16"



PHOTOMETRICS

Please see www.lithonia.com

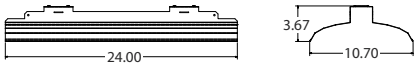
ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:
AL01b
Page 4 of 6

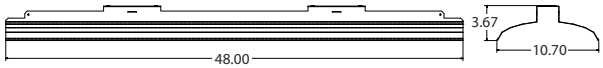
ZL1N LED Striplight

REFLECTORS (Optional)

L24 Reflector



L48 Reflector



L96 Reflector

PHOTOMETRICS

Please see www.lithonia.com

PRODUCT INFORMATION

Advanced plug-in system with two-circuit capability. Available on industrial and strip products and a variety of architectural products mounted in continuous rows. 1, 2, 3 and 4-lamp fixtures. PLR22 (2-circuit) and crossover harness switches hot circuit serving next fixture in row. Reduces fixture types on job for alternating circuit applications (see example below.)

Easy one-step installation, saves up to 35% on labor costs. Expanded switching flexibility helps save energy.

Rows can be 50% longer with two-circuit systems. Polarized, lock-together nylon connectors prevent miswiring in the field. #12 THHN conductor, rated 600V, 90°C. White neutral wire included. Grounding accomplished by fixture in-row connectors.

CSA certified systems available with up to 2 circuits. G ground required.

Note: Specifications subject to change without notice.

Wiring

PLR

Advanced 1 or 2-Circuit Plug-In

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Series	Number of hot wires	Branch circuits		Dimming	Ground
PLR	(blank) Not required for 22	Circuits to which ballast is connected	Emergency circuit connected	LV Low-voltage dimming	G Ground, required
PLR22	1 Black	(blank) Not required for 22 or PLR1	(blank) No emergency circuit		
	2 Black and red	A Black wire	ELA Emergency circuit wired to black wire		
		B Red wire	ELB Emergency circuit wired to red wire		

Typical Applications

- Multiple-circuit and single-circuit for longer continuous rows
- Multiple-circuit with alternating fixtures on separate circuits, 2-circuit (PLR 22)
- Multiple circuit with night-lights located along row as desired

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:
AL01b
Page 5 of 6

ZL1N LED Striplight

LSXR – Fixture Mount Occupancy Sensor (see www.AcuityControls.com for additional information)

- Three interchangeable lens options to satisfy multiple mounting heights and coverage pattern requirements.
- Integrated mounting bracket drops lens down 3" from chase nipple.
- Single or dual relay versions — designed with robust protection from the harsh switching requirements of T5 and LED loads.
- Photocell and 0-10VDC dimming options.
- No PIR field calibration or sensitivity adjustments required.
- Sensor ambient temperature rating of 14°F (-10°C) to 131°F (55°C).

LSXR configuration	Comparable CMRB sensor	Old style sensor nomenclature
For shortest lead times use one of the following LSXR configurations		
LC0ZU	CMRB 50	MSI
LCH0SZU	CMRB 50 D	MSID
LCPZU	CMRB 50 P	MSIPED
LA0ZU	CMRB 6	MSI360
LAH0SZU	CMRB 6 D	MSI360D
LAPZU	CMRB 6 P	MSI360PED

SELECTIONS BELOW WILL EXTEND ORDER LEAD TIME. CONSULT YOUR SALES REPRESENTATIVE FOR DETAILS.

SINGLE RELAY

ORDERING INFORMATION — **Example**: LAH0SZU

Series	Lens option	Dimming/Photocell	Max. dim level	Min. dim level	Temp/Humidity	Default occupancy time delay
L LSXR passive infrared indoor occupancy sensor	A High mount, 360° B Low mount, 360° C High mount aisleway	0 None[1] H High/low occupancy operation P Switching photocell (on/off)[1] M Dimming and switching photocell G Dimming and switching photocell with high/low occupancy operation	0 10 VDC 9 9 VDC 8 8 VDC 7 7 VDC	S Minimum dim level of ballast 1 1 VDC 2 2 VDC 3 3 VDC 4 4 VDC 5 5 VDC 6 6 VDC	Z None T Low temperature[2]	I 30 sec D 2.5 min X 5.0 min R 7.5 min U 10.0 min (with minimum 15 minute on time) V 15.0 min W 20.0 min Y 30.0 min

Notes
1 Max and min dim levels not applicable with this option.
2 Ambient temperature rating of -4°F (-20°C) to 131°F (55°C).

DUAL RELAY (Available with 120, 277, and 347V only)

ORDERING INFORMATION — **Example**: LA2KZU

Series	Lens option	Poles	Operating mode	Temp/Humidity	Default occupancy time delay
L LSXR passive infrared indoor occupancy sensor	A High mount, 360° B Low mount, 360° C High mount aisleway	2 Dual relay	J None K Alternating off relays (promotes even lamp wear) O Alternating off relays w/photocell P Switching photocell(on/off) E Photocell on/off (pole 1 only) F Photocell on/off - both poles (dual set-point)	Z None T Low temperature[1]	I 30 sec D 2.5 min X 5.0 min R 7.5 min U 10.0 min (with minimum 15 minute on time) V 15.0 min W 20.0 min Y 30.0 min

Notes
1 Ambient temperature rating of -4°F (-20°C) to 131°F (55°C).

Example: LENS 50 J100

Replacement lenses: *Order as separate catalog number.*

Series	Lens type	Package quantity
LENS	6 High mount 360° 10 Low mount 360° 50 High mount aisleway	[blank] Single Lens J10 10-pack J100 100-pack

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:
AL01b
Page 6 of 6

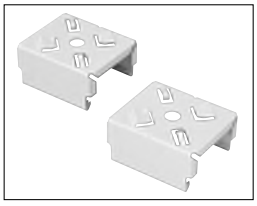
ZL1N LED Striplight

OPTIONS AND ACCESSORIES

The Z Series fixture offers numerous options for almost every electrical and optical component, including a long list of field-installable accessories.

HANGER CHAIN
36" chain with Y hanger.

Order as:
HC36



Z SPRING HANGER
Snap 'n' lock design requires no fasteners and can be used on T-grid ceiling or universal mounting systems.

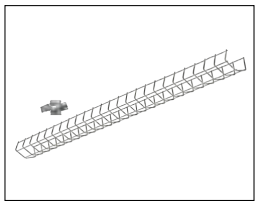
Order as:
ZSPRG

ZACVH HANGER
10' Aircraft cable with Y hanger.

Order as:
ZACVH

ANGLE MOUNTING BRACKET
Luma-tilt™ angle bracket ships as a pair

Order as:
ZLANGBKT



WIRE GUARD

Order as:
WGZ24
WGZ48

© 2013-2020 Acuity Brands Lighting, Inc. All rights reserved.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Manufacturer: LITHONIA LIGHTING : ZL1N
Description: Surface Mounted Linear

Fixture Wattage:	48 W	**Voltage:**	120 V
Lumen Output:	5642 lumen	**Fixture Finish:**	Anodized Aluminum
Lamp CRI:	90+	**Lamp CCT:**	4000K
Lighting Controls:	0-10V Dimming	**Assembly Code:**	ZL1N-L96-SMR-6000LM-SBL FST-120-40K-90CRI

LITHONIA LIGHTING®

FEATURES & SPECIFICATIONS

INTENDED USE — Built on the compact, low-profile Z strip channel, this LED strip offers long maintenance-free life, several color temperatures, lumen outputs and lengths. Ideal for new construction and retrofit applications in T5 and T8 lengths. Ideal for uplight and downlight in commercial, retail, manufacturing, warehouse, cove and display applications. **Certain airborne contaminants can diminish the integrity of acrylic and/or polycarbonate.** Click here for Acrylic-Polycarbonate Compatibility table for suitable uses.

CONSTRUCTION — Compact-design channel and cover are formed from code-gauge cold-rolled steel. Easy to install row aligner included for continuous row mounting.

Finish: Paint options include high-gloss, baked white enamel (WH), galvanized (GALV), matte black (MB) and smoke gray (SKGY). After fabrication, five-stage iron phosphate pre-treatment ensures superior paint adhesion and rust resistance.

OPTICS — Standard diffuse snap on/snap off lens eliminates pixels, improves uniformity and minimizes glare. L/LENS option available.

ELECTRICAL — L70>60,000hours. Utilizes high-output LEDs integrated on a two-layer circuit board, ensuring cool-running operation. Optional internal pluggable wiring harness for reduced labor cost in row mounting applications. (See PLR_ ordering information on page 3.) Electronic LED driver is rated for 75 input watts maximum (see Operational Data on page two for actual wattage consumption), **multi-volt input and 0-10V dimming standard**. This fixture is designed to withstand a maximum line surge of 2.5kV at 0.75kA combination wave for indoor locations, for applications requiring higher level of protection additional surge protection must be provided.

LEDs provide nominal 80 CRI at 3000 K, 3500 K,4000 K, or 5000 K.

Lumen output up to 2,000 lumens per foot. In 86°F (30°C) ambient environments. Luminaire should be installed in applications where ambient temperatures do not exceed 86°F (30°C).

INSTALLATION — Tool-less channel cover for easy installation.

Fixture may be surface mounted (with or without ZSPRG hanger), pendant or stem mounted with appropriate mounting options. Three-point aligner locks in place for easy continuous row mounting.

LISTINGS — CSA certified to US and Canadian safety standards. For use in damp locations between -40°F (-40°C) and 86°F (30°C).

DesignLights Consortium® (DLC) qualified product. Not all versions of this product may be DLC qualified. Please check the DLC Qualified Products List at www.designlights.org to confirm which versions are qualified.

WARRANTY — 5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/support/customer-support/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application.

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

Catalog Number
Notes
Type

Z SERIES

LED Striplight

ZL1N

24", 48" and 96" Lengths

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® or XPoint™ Wireless control networks marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

Type:

AL02

Page 1 of 6

Lighting Notes:

1. Mounting to be coordinated with architect.
2. Mounting and installation of conduit and routing path to be coordinated with architect.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:
AL02
Page 2 of 6

ZL1N LED Striplight

A+ Capable options indicated by this color background.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: ZL1N L48 3000LM FST MVOLT 40K 80CRI WH

Series		Length		Reflectors[2]		Nominal lumens[3]		Diffuser		Voltage	
ZL1N	LED striplight	L24	24" [1]	(blank)	Less reflector	1500LM	1,500 lumens	FST	Snap on frosted, diffuse	MVOLT	120-277V
				SMR	Symmetric	2500LM	2,500 lumens	L/LENS	No diffuser	120	120V
						3500LM	3,500 lumens	SBL FST	Straight blade louver with snap on frosted, diffuse	208	208V
		L46	46"	(blank)	Less reflector	3000LM	3,000 lumens			240	240V
		L48	48"	ASR	Asymmetric (L48 only)	5000LM	5,000 lumens			277	277V
				SMR	Symmetric	7000LM	7,000 lumens			347	347V [4]
TZL1N	LED striplight	L92	92"	(blank)	Less reflector	6000LM	6,000 lumens			480	480V [4]
		L96	96"	SMR	Symmetric	10000LM	10,000 lumens				
						14000LM	14,000 lumens				

Color temperature		Color rendering index		Options			Paint finish	
30K	3000 K	80CRI	80 CRI	PLR___	Plug-in wiring[5,6]	**Individual Controls**[5]	WH	White
35K	3500 K	90CRI	90 CRI	PLR1LVG	Plug-in wiring-low voltage[5,6]	LBOZU 360° low mount motion sensor, pre-wired [10]	GALV	Galvanized
40K	4000 K			E7W	Emergency battery pack, 7W CA Title 20 Noncompliant[7]	LBH0SZU 360° low mount motion sensor with dimming, pre-wired [10]	MB	Matte black
50K	5000 K			2E7W	Two Emergency battery packs, 7W CA Title 20 Noncompliant[7,8]	LBPZU 360° low mount motion sensor with photocell, pre-wired [10]	SKGY	Smoke gray
				E10WLCP	Emergency battery pack, 10W Linear Constant Power, Certified in CA Title 20 MAEDBS[7]	LBM0SZU 360° low mount motion sensor, dimming & switching photocell, pre-wired [10]		
				2E10WLCP	Two Emergency battery packs, 10W Linear Constant Power, Certified in CA Title 20 MAEDBS[7,8]	**Cord sets:**[11]		
				E15WLCP	Emergency battery pack, 15W Linear Constant Power, Certified in CA Title 20 MAEDBS[7,8]	CS1W Straight plug, 120V		
				OUTEND	Cord set to exit endplate of fixture	CS3W Twist-lock, 120V		
				Wireless Controls[5]		CS7W Straight plug, 277V		
				NLTAIR2 RLSXR10	nLight Air Generation 2 Fixture mount, LSXR sensor low mount 360˚	CS11W Twist-lock, 277V		
				NLTAIR2 RLSXR10EM	nLight Air Generation 2 Fixture mount, LSXR sensor low mount 360˚, UL924 Emergency operation[9]	CS25W Twist-lock, 347V		
						CS97W Twist-lock, 480V		
						CS93W 600V SEOOW white cord, no plug (no voltage required)		

Accessories: *Order as separate catalog number.*

HC36	Hanger chain, 36"	ZLR L24 SYM WH	24" symmetric reflector, white finish
ZACVH	Aircraft cable 10' (one pair)	ZLR L46 SYM UPL WH	46" symmetric reflector with uplight, white finish
ZLANGBKT	Luma-tilt™ angle bracket for shelf or ledge mounting only	ZLR L46 SYM WH	46" symmetric reflector, white finish
SQ_	Stem kit, 2" increments up to 48"	ZLR L48 ASY WH	48" asymmetric reflector, white finish
NPP16D	nLight® switching/dimming module	ZLR L48 SYM UPL WH	48" symmetric reflector with uplight, white finish
rPP20D	nLight® Air switching/dimming module	ZLR L48 SYM WH	48" symmetric reflector, white finish
LSXR	Sensor Switch® LSXR occupancy sensor [4]	ZLR L92 SYM UPL WH	92" symmetric reflector with uplight, white finish
ZSPRG	For 15/16" T-grid only	ZLR L92 SYM WH	92" symmetric reflector, white finish
WGZ24	24" wireguard, white [12]	ZLR L96 SYM UPL WH	96" symmetric reflector with uplight, white finish
WGZ48	48" wireguard, white [12,13]	ZLR L96 SYM WH	96" symmetric reflector, white finish
ZLR L24 SYM UPL WH	24" symmetric reflector with uplight, white finish	UNIVERSAL REFL ALIGNER	Universal reflector aligners, quantity 1

Notes

1 Not available with 347V, 480V or Batteries
2 Optional. Reflectors ship separately.
3 See Operational Data on page 2 for actual lumens.
4 Utilizes step down transformer.
5 See ordering information on pages 4 and 5 and rLSXR specification sheet for more configurations. When choosing Sensor and PLR for same fixture, consult the factory.
6 Not available with cord sets.
7 MVOLT only. Not available with cord sets with plugs. Battery Spec sheet linked for more information.
8 Only available with 10,000LM and 14,000LM packages.
9 MVOLT only.
10 Available with MVOLT, 347V and 480V only. This sensor configuration is suitable for minimum ambient temperature of 14°F (-10°C). See page 6 for low temperature option providing -4°F (-20°C) minimum ambient Sensors come prewired, they must be snapped into place at time of installation.
11 Cordsets exit back of fixture unless OUTEND option is specified. Must specify voltage (not required when ordering CS93W).
12 Not compatible with reflector
13 Order 2 for tandem double length fixtures (TZL1N).

ARUP
Project Number: 271565
Phone: 1 212 896 3000

ZL1N LED Striplight

Type:

AL02

OPERATIONAL DATA

	Nominal lumen package	Length (inches)	Delivered Lumens 3000 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 3500 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 4000 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 5000 K CCT @ 77°F (25°C) ambient temperature		Wattage @ 120V/277V	Comparable Light Source
			80 CRI	90 CRI	80 CRI	90 CRI	80 CRI	90 CRI	80 CRI	90 CRI		
Lensed	1500LM	24	1738	1409	1777	1467	1804	1494	1871	1528	15	1-lamp 17W T8
	2500LM	24	2265	1846	2315	1900	2351	1947	2438	1991	19	1-lamp 17W T8
	3500LM	24	3586	2924	3666	3026	3723	3084	3860	3152	31	1-lamp 32W T8, 1-lamp 54W T5HO, 50W HID
	3000LM	46 or 48	3172	2586	3243	2677	3293	2728	3415	2788	25	1-lamp 32W T8, 1-lamp 54W T5HO, 50W HID
	5000LM	46 or 48	4417	3601	4515	3727	4585	3798	4754	3882	34	2-lamp 32W T8, 1-lamp 54W T5HO, 70W HID
	7000LM	46 or 48	6535	5328	6681	5515	6785	5619	7035	5744	52	3-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	6000LM	92 or 96	6561	5349	6708	5537	6812	5642	7063	5767	48	3-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	10000LM	92 or 96	8687	7082	8881	7331	9019	7470	9351	7636	68	4-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	14000LM	92 or 96	12457	10513	12735	10665	12933	10711	13409	10949	104	4-lamp 32W T8, 3-lamp 54W T5HO, 150W HID
Unlensed	1500LM	24	1881	1534	1923	1588	1953	1618	2025	1654	15	1-lamp 17W T8
	2500LM	24	2452	1999	2506	2069	2545	2108	2639	2155	19	1-lamp 17W T8
	3500LM	24	3882	3165	3969	3276	4031	3338	4179	3412	31	1-lamp 32W T8, 1-lamp 54W T5HO, 50W HID
	3000LM	46 or 48	3434	2800	3511	2898	3565	2953	3697	3019	25	1-lamp 32W T8, 1-lamp 54W T5HO, 50W HID
	5000LM	46 or 48	4781	3898	4888	4035	4964	4111	5147	4203	34	2-lamp 32W T8, 1-lamp 54W T5HO, 70W HID
	7000LM	46 or 48	7075	5768	7233	5971	7345	6083	7616	6219	52	3-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	6000LM	92 or 96	7103	5791	7261	5995	7374	6108	7646	6243	48	3-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	10000LM	92 or 96	9404	7667	9614	7937	9764	8087	10123	8266	68	4-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	14000LM	92 or 96	13485	10994	13786	11381	14001	11596	14516	11853	104	4-lamp 32W T8, 3-lamp 54W T5HO, 150W HID

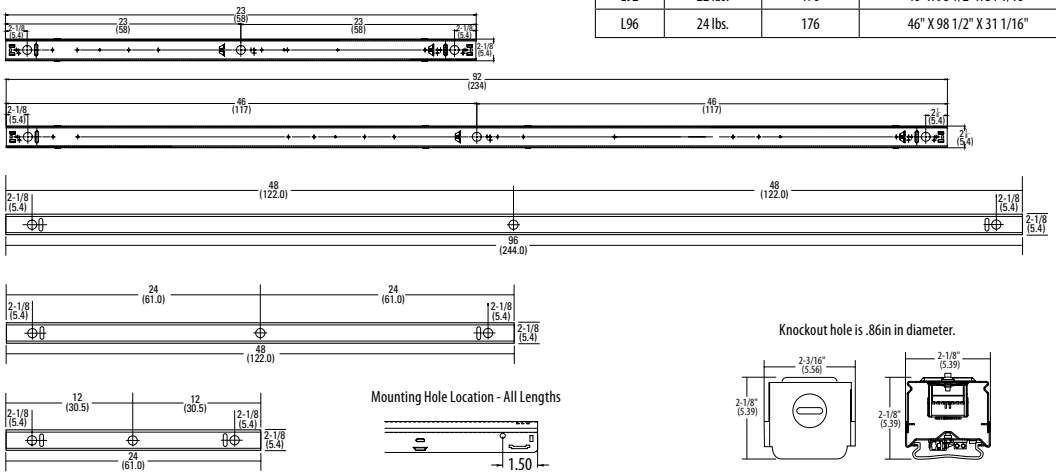
DIMENSIONS

All dimensions are shown in inches (centimeters) unless otherwise noted.

Specifications subject to change without notice.

PALLET DIMENSIONS

Length	Approximate weight	Fixtures per pallet	Approximate pallet dimensions (L x W x H)
L24	7 lbs.	408	46" X 51" X 32 11/16"
L46	11 lbs.	176	46" X 51" X 32 1/16"
L48	12 lbs.	176	46" X 51" X 31 3/8"
L92	22 lbs.	176	46" X 98 1/2" X 31 1/16"
L96	24 lbs.	176	46" X 98 1/2" X 31 1/16"



Mounting Hole Location - All Lengths

Knockout hole is .86in in diameter.

PHOTOMETRICS

Please see www.lithonia.com

ARUP
Project Number: 271565
Phone: 1 212 896 3000

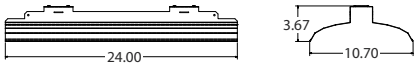
Type:

AL02

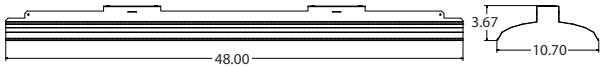
ZL1N LED Striplight

REFLECTORS (Optional)

L24 Reflector



L48 Reflector



L96 Reflector

PHOTOMETRICS

Please see www.lithonia.com

PRODUCT INFORMATION

Advanced plug-in system with two-circuit capability. Available on industrial and strip products and a variety of architectural products mounted in continuous rows. 1, 2, 3 and 4-lamp fixtures. PLR22 (2-circuit) and crossover harness switches hot circuit serving next fixture in row. Reduces fixture types on job for alternating circuit applications (see example below.)

Easy one-step installation, saves up to 35% on labor costs. Expanded switching flexibility helps save energy.

Rows can be 50% longer with two-circuit systems. Polarized, lock-together nylon connectors prevent miswiring in the field. #12 THHN conductor, rated 600V, 90°C. White neutral wire included. Grounding accomplished by fixture in-row connectors.

CSA certified systems available with up to 2 circuits. G ground required.

Note: Specifications subject to change without notice.

Wiring

PLR

Advanced 1 or 2-Circuit Plug-In

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Series	Number of hot wires	Branch circuits		Dimming	Ground
PLR	(blank) Not required for 22	Circuits to which ballast is connected	Emergency circuit connected	LV Low-voltage dimming	G Ground, required
PLR22	1 Black	(blank) Not required for 22 or PLR1	(blank) No emergency circuit		
	2 Black and red	A Black wire	ELA Emergency circuit wired to black wire		
		B Red wire	ELB Emergency circuit wired to red wire		

Typical Applications

- Multiple-circuit and single-circuit for longer continuous rows
- Multiple-circuit with alternating fixtures on separate circuits, 2-circuit (PLR 22)
- Multiple circuit with night-lights located along row as desired

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:

AL02

ZL1N LED Striplight

LSXR – Fixture Mount Occupancy Sensor (see www.AcuityControls.com for additional information)

- Three interchangeable lens options to satisfy multiple mounting heights and coverage pattern requirements.
- Integrated mounting bracket drops lens down 3" from chase nipple.
- Single or dual relay versions — designed with robust protection from the harsh switching requirements of T5 and LED loads.
- Photocell and 0-10VDC dimming options.
- No PIR field calibration or sensitivity adjustments required.
- Sensor ambient temperature rating of 14°F (-10°C) to 131°F (55°C).

LSXR configuration	Comparable CMRB sensor	Old style sensor nomenclature
For shortest lead times use one of the following LSXR configurations		
LC0ZU	CMRB 50	MSI
LCH0SZU	CMRB 50 D	MSID
LCPZU	CMRB 50 P	MSIPED
LA0ZU	CMRB 6	MSI360
LAH0SZU	CMRB 6 D	MSI360D
LAPZU	CMRB 6 P	MSI360PED

SELECTIONS BELOW WILL EXTEND ORDER LEAD TIME. CONSULT YOUR SALES REPRESENTATIVE FOR DETAILS.

SINGLE RELAY

ORDERING INFORMATION — **Example**: LAH0SZU

Series	Lens option	Dimming/Photocell	Max. dim level	Min. dim level	Temp/Humidity	Default occupancy time delay
L LSXR passive infrared indoor occupancy sensor	A High mount, 360° B Low mount, 360° C High mount aisleway	0 None[1] H High/low occupancy operation P Switching photocell (on/off)[1] M Dimming and switching photocell G Dimming and switching photocell with high/low occupancy operation	0 10 VDC 9 9 VDC 8 8 VDC 7 7 VDC	S Minimum dim level of ballast 1 1 VDC 2 2 VDC 3 3 VDC 4 4 VDC 5 5 VDC 6 6 VDC	Z None T Low temperature[2]	I 30 sec D 2.5 min X 5.0 min R 7.5 min U 10.0 min (with minimum 15 minute on time) V 15.0 min W 20.0 min Y 30.0 min

Notes

1 Max and min dim levels not applicable with this option.

2 Ambient temperature rating of -4°F (-20°C) to 131°F (55°C).

DUAL RELAY (Available with 120, 277, and 347V only)

ORDERING INFORMATION — **Example**: LA2KZU

Series	Lens option	Poles	Operating mode	Temp/Humidity	Default occupancy time delay
L LSXR passive infrared indoor occupancy sensor	A High mount, 360° B Low mount, 360° C High mount aisleway	2 Dual relay	J None K Alternating off relays (promotes even lamp wear) O Alternating off relays w/photocell P Switching photocell(on/off) E Photocell on/off (pole 1 only) F Photocell on/off - both poles (dual set-point)	Z None T Low temperature[1]	I 30 sec D 2.5 min X 5.0 min R 7.5 min U 10.0 min (with minimum 15 minute on time) V 15.0 min W 20.0 min Y 30.0 min

Notes

1 Ambient temperature rating of -4°F (-20°C) to 131°F (55°C).

Example: LENS 50 J100

Replacement lenses: *Order as separate catalog number.*

Series	Lens type	Package quantity
LENS	6 High mount 360° 10 Low mount 360° 50 High mount aisleway	[blank] Single Lens J10 10-pack J100 100-pack

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:

AL02

Page 6 of 6

ZL1N LED Striplight

OPTIONS AND ACCESSORIES

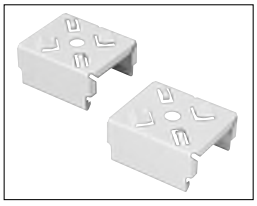
The Z Series fixture offers numerous options for almost every electrical and optical component, including a long list of field-installable accessories.

HANGER CHAIN

36" chain with Y hanger.

Order as:

HC36



Z SPRING HANGER

Snap 'n' lock design requires no fasteners and can be used on T-grid ceiling or universal mounting systems.

Order as:

ZSPRG

ZACVH HANGER

10' Aircraft cable with Y hanger.

Order as:

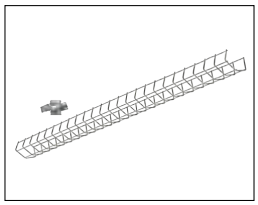
ZACVH

ANGLE MOUNTING BRACKET

Luma-tilt™ angle bracket ships as a pair

Order as:

ZLANGBKT



WIRE GUARD

Order as:

WGZ24

WGZ48

© 2013-2020 Acuity Brands Lighting, Inc. All rights reserved.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Manufacturer: LITHONIA LIGHTING : ZL1N
Description: Surface Mounted Linear

Fixture Wattage: 25 W
Lumen Output: 2728 lumen
Lamp CRI: 90+
Lighting Controls: 0-10V Dimming

Voltage: 120 V
Fixture Finish: Anodized Aluminum
Lamp CCT: 4000K
Assembly Code: ZL1N-L48-SMR-3000LM-SBL FST-120-40K-90CRI

LITHONIA LIGHTING®

FEATURES & SPECIFICATIONS

INTENDED USE — Built on the compact, low-profile Z strip channel, this LED strip offers long maintenance-free life, several color temperatures, lumen outputs and lengths. Ideal for new construction and retrofit applications in T5 and T8 lengths. Ideal for uplight and downlight in commercial, retail, manufacturing, warehouse, cove and display applications. **Certain airborne contaminants can diminish the integrity of acrylic and/or polycarbonate.** Click here for Acrylic-Polycarbonate Compatibility table for suitable uses.

CONSTRUCTION — Compact-design channel and cover are formed from code-gauge cold-rolled steel. Easy to install row aligner included for continuous row mounting.

Finish: Paint options include high-gloss, baked white enamel (WH), galvanized (GALV), matte black (MB) and smoke gray (SKGY). After fabrication, five-stage iron phosphate pre-treatment ensures superior paint adhesion and rust resistance.

OPTICS — Standard diffuse snap on/snap off lens eliminates pixels, improves uniformity and minimizes glare. L/LENS option available.

ELECTRICAL — L70>60,000hours. Utilizes high-output LEDs integrated on a two-layer circuit board, ensuring cool-running operation. Optional internal pluggable wiring harness for reduced labor cost in row mounting applications. (See PLR_ ordering information on page 3.) Electronic LED driver is rated for 75 input watts maximum (see Operational Data on page two for actual wattage consumption), **multi-volt input and 0-10V dimming standard**. This fixture is designed to withstand a maximum line surge of 2.5kV at 0.75kA combination wave for indoor locations, for applications requiring higher level of protection additional surge protection must be provided.

LEDs provide nominal 80 CRI at 3000 K, 3500 K,4000 K, or 5000 K.

Lumen output up to 2,000 lumens per foot. In 86°F (30°C) ambient environments. Luminaire should be installed in applications where ambient temperatures do not exceed 86°F (30°C).

INSTALLATION — Tool-less channel cover for easy installation.

Fixture may be surface mounted (with or without ZSPRG hanger), pendant or stem mounted with appropriate mounting options. Three-point aligner locks in place for easy continuous row mounting.

LISTINGS — CSA certified to US and Canadian safety standards. For use in damp locations between -40°F (-40°C) and 86°F (30°C).

DesignLights Consortium® (DLC) qualified product. Not all versions of this product may be DLC qualified. Please check the DLC Qualified Products List at www.designlights.org to confirm which versions are qualified.

WARRANTY — 5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/support/customer-support/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application.

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

Catalog Number
Notes
Type

LED Striplight

ZL1N

24", 48" and 96" Lengths

L/Lens

Lensed

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® or XPoint™ Wireless control networks marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

Type:
AL02a

Page 1 of 6

Lighting Notes:

1. Mounting to be coordinated with architect
2. Mounting and installation of conduit and routing path to be coordinated with architect.

INDUSTRIAL

ZL1N
Page 1 of 6

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:
AL02a
Page 2 of 6

ZL1N LED Striplight

A+ Capable options indicated by this color background.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: ZL1N L48 3000LM FST MVOLT 40K 80CRI WH

Series		Length		Reflectors[2]		Nominal lumens[3]		Diffuser		Voltage	
ZL1N	LED striplight	L24	24"[1]	(blank)	Less reflector	1500LM	1,500 lumens	FST	Snap on frosted, diffuse	MVOLT	120-277V
				SMR	Symmetric	2500LM	2,500 lumens	L/LENS	No diffuser	120	120V
						3500LM	3,500 lumens	SBL FST	Straight blade louver with snap on frosted, diffuse	208	208V
		L46	46"	(blank)	Less reflector	3000LM	3,000 lumens			240	240V
		L48	48"	ASR	Asymmetric (L48 only)	5000LM	5,000 lumens			277	277V
				SMR	Symmetric	7000LM	7,000 lumens			347	347V[4]
TZL1N	LED striplight	L92	92"	(blank)	Less reflector	6000LM	6,000 lumens			480	480V[4]
		L96	96"	SMR	Symmetric	10000LM	10,000 lumens				
						14000LM	14,000 lumens				

Color temperature		Color rendering index		Options			Paint finish	
30K	3000 K	80CRI	80 CRI	PLR___	Plug-in wiring[5,6]	**Individual Controls**[5]	WH	White
35K	3500 K	90CRI	90 CRI	PLR1LVG	Plug-in wiring-low voltage[5,6]	LBOZU 360° low mount motion sensor, pre-wired[10]	GALV	Galvanized
40K	4000 K			E7W	Emergency battery pack, 7W CA Title 20 Noncompliant[7]	LBH0SZU 360° low mount motion sensor with dimming, pre-wired[10]	MB	Matte black
50K	5000 K			2E7W	Two Emergency battery packs, 7W CA Title 20 Noncompliant[7,8]	LBPZU 360° low mount motion sensor with photocell, pre-wired[10]	SKGY	Smoke gray
				E10WLCP	Emergency battery pack, 10W Linear Constant Power, Certified in CA Title 20 MAEDBS[7]	LBM0SZU 360° low mount motion sensor, dimming & switching photocell, pre-wired[10]		
				2E10WLCP	Two Emergency battery packs, 10W Linear Constant Power, Certified in CA Title 20 MAEDBS[7,8]	**Cord sets:**[11]		
				E15WLCP	Emergency battery pack, 15W Linear Constant Power, Certified in CA Title 20 MAEDBS[7,8]	CS1W Straight plug, 120V		
				OUTEND	Cord set to exit endplate of fixture	CS3W Twist-lock, 120V		
				Wireless Controls[5]		CS7W Straight plug, 277V		
				NLTAIR2 RLSXR10	nLight Air Generation 2 Fixture mount, LSXR sensor low mount 360˚	CS11W Twist-lock, 277V		
				NLTAIR2 RLSXR10EM	nLight Air Generation 2 Fixture mount, LSXR sensor low mount 360˚, UL924 Emergency operation[9]	CS25W Twist-lock, 347V		
						CS97W Twist-lock, 480V		
						CS93W 600V SEOOW white cord, no plug (no voltage required)		

Accessories: *Order as separate catalog number.*

HC36	Hanger chain, 36"	ZLR L24 SYM WH	24" symmetric reflector, white finish
ZACVH	Aircraft cable 10' (one pair)	ZLR L46 SYM UPL WH	46" symmetric reflector with uplight, white finish
ZLANGBKT	Luma-tilt™ angle bracket for shelf or ledge mounting only	ZLR L46 SYM WH	46" symmetric reflector, white finish
SQ_	Stem kit, 2" increments up to 48"	ZLR L48 ASY WH	48" asymmetric reflector, white finish
NPP16D	nLight® switching/dimming module	ZLR L48 SYM UPL WH	48" symmetric reflector with uplight, white finish
rPP20D	nLight® Air switching/dimming module	ZLR L48 SYM WH	48" symmetric reflector, white finish
LSXR	Sensor Switch® LSXR occupancy sensor[4]	ZLR L92 SYM UPL WH	92" symmetric reflector with uplight, white finish
ZSPRG	For 15/16" T-grid only	ZLR L92 SYM WH	92" symmetric reflector, white finish
WGZ24	24" wireguard, white[12]	ZLR L96 SYM UPL WH	96" symmetric reflector with uplight, white finish
WGZ48	48" wireguard, white[12,13]	ZLR L96 SYM WH	96" symmetric reflector, white finish
ZLR L24 SYM UPL WH	24" symmetric reflector with uplight, white finish	UNIVERSAL REFL ALIGNER	Universal reflector aligners, quantity 1

Notes

1 Not available with 347V, 480V or Batteries
2 Optional. Reflectors ship separately.
3 See Operational Data on page 2 for actual lumens.
4 Utilizes step down transformer.
5 See ordering information on pages 4 and 5 and rLSXR specification sheet for more configurations. When choosing Sensor and PLR for same fixture, consult the factory.
6 Not available with cord sets.
7 MVOLT only. Not available with cord sets with plugs. Battery Spec sheet linked for more information.
8 Only available with 10,000LM and 14,000LM packages.
9 MVOLT only.
10 Available with MVOLT, 347V and 480V only. This sensor configuration is suitable for minimum ambient temperature of 14°F (-10°C). See page 6 for low temperature option providing -4°F (-20°C) minimum ambient Sensors come prewired, they must be snapped into place at time of installation.
11 Cordsets exit back of fixture unless OUTEND option is specified. Must specify voltage (not required when ordering CS93W).
12 Not compatible with reflector
13 Order 2 for tandem double length fixtures (TZL1N).

ARUP
Project Number: 271565
Phone: 1 212 896 3000

ZL1N LED Striplight

Type:
AL02a

OPERATIONAL DATA

	Nominal lumen package	Length (inches)	Delivered Lumens 3000 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 3500 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 4000 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 5000 K CCT @ 77°F (25°C) ambient temperature		Wattage @ 120V/277V	Comparable Light Source
			80 CRI	90 CRI	80 CRI	90 CRI	80 CRI	90 CRI	80 CRI	90 CRI		
Lensed	1500LM	24	1738	1409	1777	1467	1804	1494	1871	1528	15	1-lamp 17W T8
	2500LM	24	2265	1846	2315	1900	2351	1947	2438	1991	19	1-lamp 17W T8
	3500LM	24	3586	2924	3666	3026	3723	3084	3860	3152	31	1-lamp 32W T8, 1-lamp 54W T5H0, 50W HID
	3000LM	46 or 48	3172	2586	3243	2677	3293	2728	3415	2788	25	1-lamp 32W T8, 1-lamp 54W T5H0, 50W HID
	5000LM	46 or 48	4417	3601	4515	3727	4585	3798	4754	3882	34	2-lamp 32W T8, 1-lamp 54W T5H0, 70W HID
	7000LM	46 or 48	6535	5328	6681	5515	6785	5619	7035	5744	52	3-lamp 32W T8, 2-lamp 54W T5H0, 100W HID
	6000LM	92 or 96	6561	5349	6708	5537	6812	5642	7063	5767	48	3-lamp 32W T8, 2-lamp 54W T5H0, 100W HID
	10000LM	92 or 96	8687	7082	8881	7331	9019	7470	9351	7636	68	4-lamp 32W T8, 2-lamp 54W T5H0, 100W HID
	14000LM	92 or 96	12457	10513	12735	10665	12933	10711	13409	10949	104	4-lamp 32W T8, 3-lamp 54W T5H0, 150W HID
Unlensed	1500LM	24	1881	1534	1923	1588	1953	1618	2025	1654	15	1-lamp 17W T8
	2500LM	24	2452	1999	2506	2069	2545	2108	2639	2155	19	1-lamp 17W T8
	3500LM	24	3882	3165	3969	3276	4031	3338	4179	3412	31	1-lamp 32W T8, 1-lamp 54W T5H0, 50W HID
	3000LM	46 or 48	3434	2800	3511	2898	3565	2953	3697	3019	25	1-lamp 32W T8, 1-lamp 54W T5H0, 50W HID
	5000LM	46 or 48	4781	3898	4888	4035	4964	4111	5147	4203	34	2-lamp 32W T8, 1-lamp 54W T5H0, 70W HID
	7000LM	46 or 48	7075	5768	7233	5971	7345	6083	7616	6219	52	3-lamp 32W T8, 2-lamp 54W T5H0, 100W HID
	6000LM	92 or 96	7103	5791	7261	5995	7374	6108	7646	6243	48	3-lamp 32W T8, 2-lamp 54W T5H0, 100W HID
	10000LM	92 or 96	9404	7667	9614	7937	9764	8087	10123	8266	68	4-lamp 32W T8, 2-lamp 54W T5H0, 100W HID
	14000LM	92 or 96	13485	10994	13786	11381	14001	11596	14516	11853	104	4-lamp 32W T8, 3-lamp 54W T5H0, 150W HID

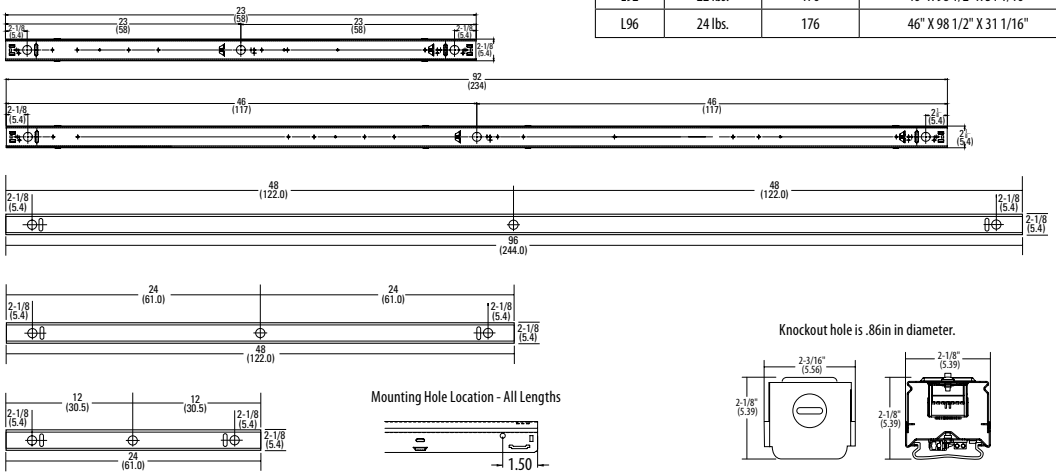
DIMENSIONS

All dimensions are shown in inches (centimeters) unless otherwise noted.

Specifications subject to change without notice.

PALLET DIMENSIONS

Length	Approximate weight	Fixtures per pallet	Approximate pallet dimensions (L x W x H)
L24	7 lbs.	408	46" X 51" X 32 11/16"
L46	11 lbs.	176	46" X 51" X 32 1/16"
L48	12 lbs.	176	46" X 51" X 31 3/8"
L92	22 lbs.	176	46" X 98 1/2" X 31 1/16"
L96	24 lbs.	176	46" X 98 1/2" X 31 1/16"



PHOTOMETRICS

Please see www.lithonia.com

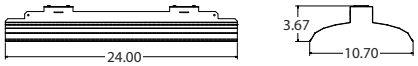
ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:
AL02a
Page 4 of 6

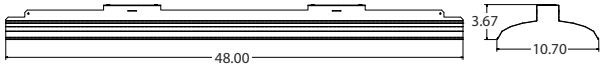
ZL1N LED Striplight

REFLECTORS (Optional)

L24 Reflector



L48 Reflector



L96 Reflector

PHOTOMETRICS

Please see www.lithonia.com

PRODUCT INFORMATION

Advanced plug-in system with two-circuit capability. Available on industrial and strip products and a variety of architectural products mounted in continuous rows. 1, 2, 3 and 4-lamp fixtures. PLR22 (2-circuit) and crossover harness switches hot circuit serving next fixture in row. Reduces fixture types on job for alternating circuit applications (see example below.)

Easy one-step installation, saves up to 35% on labor costs. Expanded switching flexibility helps save energy.

Rows can be 50% longer with two-circuit systems. Polarized, lock-together nylon connectors prevent miswiring in the field. #12 THHN conductor, rated 600V, 90°C. White neutral wire included. Grounding accomplished by fixture in-row connectors.

CSA certified systems available with up to 2 circuits. G ground required.

Note: Specifications subject to change without notice.

Wiring

PLR

Advanced 1 or 2-Circuit Plug-In

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Series	Number of hot wires	Branch circuits		Dimming	Ground
PLR	(blank) Not required for 22	Circuits to which ballast is connected	Emergency circuit connected	LV Low-voltage dimming	G Ground, required
PLR22	1 Black	(blank) Not required for 22 or PLR1	(blank) No emergency circuit		
	2 Black and red	A Black wire	ELA Emergency circuit wired to black wire		
		B Red wire	ELB Emergency circuit wired to red wire		

Typical Applications

- Multiple-circuit and single-circuit for longer continuous rows
- Multiple-circuit with alternating fixtures on separate circuits, 2-circuit (PLR 22)
- Multiple circuit with night-lights located along row as desired

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:
AL02a
Page 5 of 6

ZL1N LED Striplight

LSXR – Fixture Mount Occupancy Sensor (see www.AcuityControls.com for additional information)

- Three interchangeable lens options to satisfy multiple mounting heights and coverage pattern requirements.
- Integrated mounting bracket drops lens down 3" from chase nipple.
- Single or dual relay versions — designed with robust protection from the harsh switching requirements of T5 and LED loads.
- Photocell and 0-10VDC dimming options.
- No PIR field calibration or sensitivity adjustments required.
- Sensor ambient temperature rating of 14°F (-10°C) to 131°F (55°C).

LSXR configuration	Comparable CMRB sensor	Old style sensor nomenclature
For shortest lead times use one of the following LSXR configurations		
LC0ZU	CMRB 50	MSI
LCH0SZU	CMRB 50 D	MSID
LCPZU	CMRB 50 P	MSIPED
LA0ZU	CMRB 6	MSI360
LAH0SZU	CMRB 6 D	MSI360D
LAPZU	CMRB 6 P	MSI360PED

SELECTIONS BELOW WILL EXTEND ORDER LEAD TIME. CONSULT YOUR SALES REPRESENTATIVE FOR DETAILS.

SINGLE RELAY

ORDERING INFORMATION — **Example**: LAH0SZU

Series	Lens option	Dimming/Photocell	Max. dim level	Min. dim level	Temp/Humidity	Default occupancy time delay
L LSXR passive infrared indoor occupancy sensor	A High mount, 360° B Low mount, 360° C High mount aisleway	0 None[1] H High/low occupancy operation P Switching photocell (on/off)[1] M Dimming and switching photocell G Dimming and switching photocell with high/low occupancy operation	0 10 VDC 9 9 VDC 8 8 VDC 7 7 VDC	S Minimum dim level of ballast 1 1 VDC 2 2 VDC 3 3 VDC 4 4 VDC 5 5 VDC 6 6 VDC	Z None T Low temperature[2]	I 30 sec D 2.5 min X 5.0 min R 7.5 min U 10.0 min (with minimum 15 minute on time) V 15.0 min W 20.0 min Y 30.0 min

Notes
1 Max and min dim levels not applicable with this option.
2 Ambient temperature rating of -4°F (-20°C) to 131°F (55°C).

DUAL RELAY (Available with 120, 277, and 347V only)

ORDERING INFORMATION — **Example**: LA2KZU

Series	Lens option	Poles	Operating mode	Temp/Humidity	Default occupancy time delay
L LSXR passive infrared indoor occupancy sensor	A High mount, 360° B Low mount, 360° C High mount aisleway	2 Dual relay	J None K Alternating off relays (promotes even lamp wear) O Alternating off relays w/photocell P Switching photocell(on/off) E Photocell on/off (pole 1 only) F Photocell on/off - both poles (dual set-point)	Z None T Low temperature[1]	I 30 sec D 2.5 min X 5.0 min R 7.5 min U 10.0 min (with minimum 15 minute on time) V 15.0 min W 20.0 min Y 30.0 min

Notes
1 Ambient temperature rating of -4°F (-20°C) to 131°F (55°C).

Example: LENS 50 J100

Replacement lenses: *Order as separate catalog number.*

Series	Lens type	Package quantity
LENS	6 High mount 360° 10 Low mount 360° 50 High mount aisleway	[blank] Single Lens J10 10-pack J100 100-pack

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:
AL02a
Page 6 of 6

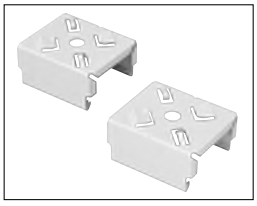
ZL1N LED Striplight

OPTIONS AND ACCESSORIES

The Z Series fixture offers numerous options for almost every electrical and optical component, including a long list of field-installable accessories.

HANGER CHAIN
36" chain with Y hanger.

Order as:
HC36



Z SPRING HANGER
Snap 'n' lock design requires no fasteners and can be used on T-grid ceiling or universal mounting systems.

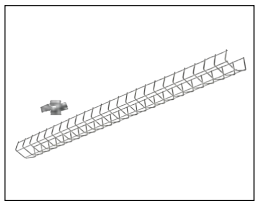
Order as:
ZSPRG

ZACVH HANGER
10' Aircraft cable with Y hanger.

Order as:
ZACVH

ANGLE MOUNTING BRACKET
Luma-tilt™ angle bracket ships as a pair

Order as:
ZLANGBKT



WIRE GUARD

Order as:
WGZ24
WGZ48

© 2013-2020 Acuity Brands Lighting, Inc. All rights reserved.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Manufacturer: CORONET : LSR2 LED LTG1
Description: Recessed Linear

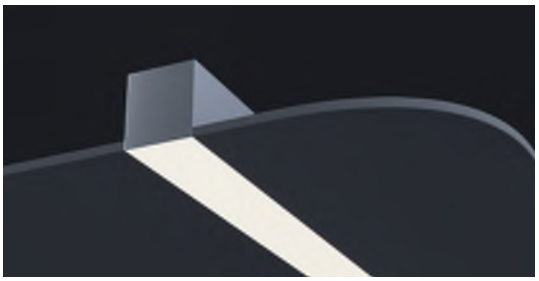
Fixture Wattage: 29 W
Lumen Output: 2700 lumen
Lamp CRI: 90+
Lighting Controls: 0-10V Dimming

Voltage: 120 V
Fixture Finish: Galvanized, Clear anodized or custom RAL
Lamp CCT: 4000K
Assembly Code: LSR2 LED 4 40 LTG1 UNV DB1% CC F SD

Coronet

LSR2 LED

DATE	PROJECT	FIRM	TYPE



Narrow, recessed, architectural luminaire with semi-recessed lens (protrudes 3/8" from ceiling). For use in indoor applications where an LED luminaire with small profile providing continuous light is required. Suitable for grid systems or drywall installation as well as custom mounting requests.

FEATURES

- Available In Made To Measure Lengths Accurate Up To 1/16"
- Patterns Available (See Page 3)
- Damp Location Rated
- CRI 90+ Standard; R9>50
- 5 Year, 50,000 Hour Fixture Warranty
- 2700K, 3000K, 3500K, 4000K & 5000K Color Temperatures Available
- Available with PoE

APPLICATIONS Offices, Lobbies, Retail Stores, Classrooms, Reception Areas & Corridors

CONSTRUCTION Extruded Aluminum Housing with Steel End Caps. Formed Steel Gear Tray

OPTICS Extruded High Transmission Satin Acrylic Lens with No LED Imaging. Flat Lens Optional

WARRANTY 5 Year Limited Warranty (Covers Standard Components)

FINISH Standard Powder-Coated White. Custom RAL Colors Available

FIXTURE RATINGS & CERTIFICATIONS Union Made, Made In The USA, ETL Listed, Damp Location Rated

*Must Specify JA8 Compliant Driver

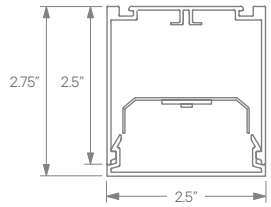
ELECTRICAL Integral Driver with 0-10V Dimming Standard. Several Driver Options Available

DRIVERS & SENSORS

For Wiring Diagrams and Sensor Information Click Here

EXTRUSION DIMENSIONS

NOTE: STANDARD LENS SITS 1/4" BELOW EXTRUDED HOUSING. FLUSH LENS OPTION AVAILABLE.



LED SYSTEM INFORMATION

	Nominal System Watts	Nominal Delivered Lumens	Nominal Efficacy
Standard (LTG1)	7.25 W/ft	675 lm/ft	94 LPW
Low (LTG2)	5 W/ft	508 lm/ft	95 LPW
High (LTG3)	10 W/ft	914 lm/ft	92 LPW

Based on a 3500K luminaire using one driver. Custom outputs available; specify below.

ORDERING

1	2	3	4	5	6	7	8	9	10	11	12

1 - FIXTURE ID
LSR2 LED

2 - LENGTH
2 - 2 ft
4 - 4 ft
8 - 8 ft
X'-X" - Specify Length
PAT - Pattern (Consult Factory)

3 - COLOR TEMP
27 - 2700K/90 CRI
30 - 3000K/90 CRI
35 - 3500K/90 CRI
40 - 4000K/90 CRI
50 - 5000K/90 CRI
TW* - Tunable White
RGBW** - RGB+3000K
*Must use DMX or TW10 Driver
**Must use DMX Driver

4 - LED SYSTEM
LTG1 - Standard
LTG2 - Low
LTG3 - High
LTGC - Custom Output

5 - VOLTAGE
UNV - Universal (120/277V)

6 - DRIVER
DB - Standard Dimming (0-10V)
DB1% - 1% Dimming (0-10V)
DB.1% - 0.1% Dimming (0-10V)
LTEA - Lutron 2-wire 1% Dimming (120V only)
LDE1 - Lutron Digital EcoSystem
LDE5 - 5 Series EcoSystem; 5% Dimming
JA8 - JA8 Compliant 1% Dimming (0-10V)
PoE - Power over Ethernet. Consult Factory for Compatibility
DMX - For Color Tuning and RGBW (Remote)
TW10 - Dual Channel, 0-10V For Color Tuning (CCT and Intensity Control)

7 - FINISH
W - White (Standard)
CC - Custom Color (provide RAL#)

8 - MOUNTING
T - 9/16" Tee Grid
T15 - 15/16" Tee Grid
SG - Slot Grid/Interlude
F - Flange
NT - No Trim/Spackle Flange
PM-X* - Perimeter Mount
*"X" denotes mounting type on opposite side of wall (ie-**PM-NT**). Consult Factory

9 - OPTICS
SD - Standard Diffuser
FL - Flat Lens

10 - CONTROL (Optional)
EIS - Enlighted Sensor
WISD - Wattstopper Daylight Sensor
WISM - Wattstopper Occupancy Sensor
SLS - SensiLUM Sensor
ACS - Acuity Controls nLight System
CCS - Casambi Compatible
ECS - Eaton WaveLinx System
*For other control systems not listed consult factory.

11 - CIRCUIT (Optional)
EM 120V - Emergency Pack
EM 277V - Emergency Pack

11 - OTHER OPTIONS
WH6 - 6ft Whips Preinstalled
CP - Chicago Plenum

Updated: 07/21/2020

CORONET, Inc.
55 Shepherds Lane
Totowa, NJ 07512

T 973 345 7660
F 973 345 8705

CORONET, Inc. reserves the right to make any design changes for continuous improvement which will not affect the overall appearance or performance.

WWW.CORONETLED.COM

1/3

Type:

AL12

Lighting Notes:

1. Contractor to verify mounting type compatibility with ceiling type.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Coronet

LSR2 LED

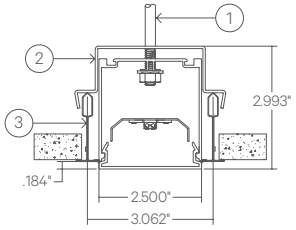
Type: AL12

Page 2 of 3

DATE	PROJECT	FIRM	TYPE

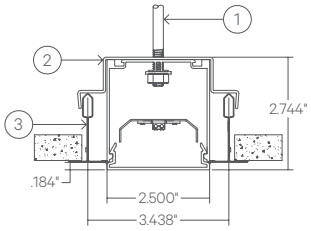
MOUNTING OPTIONS

T - 9/16" Tee Grid



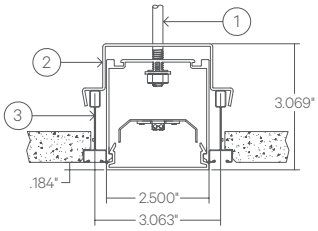
1 - Threaded Rod (not supplied)
2 - Tee Grid Bracket
3 - Tee Grid

T15 - 15/16" Tee Grid



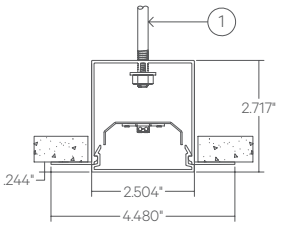
1 - Threaded Rod (not supplied)
2 - Tee Grid Bracket
3 - Tee Grid

SG - Slot Grid/Interlude



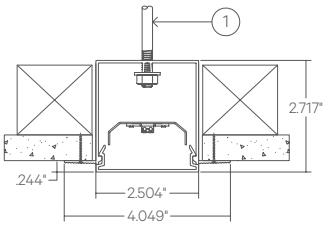
1 - Threaded Rod (not supplied)
2 - Slot Grid Bracket
3 - Slot Grid

F - Flange



1 - Threaded Rod (not supplied)

NT - No Trim/Spackle Flange



1 - Threaded Rod (not supplied)

Updated: 07/21/2020

CORONET, Inc.
55 Shepherds Lane
Totowa, NJ 07512

T 973 345 7660
F 973 345 8705

CORONET, Inc. reserves the right to make any design changes for continuous improvement which will not affect the overall appearance or performance.

WWW.CORONETLED.COM

2/3

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Coronet

LSR2 LED

Type: AL12

Page 3 of 3

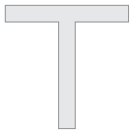
DATE	PROJECT	FIRM	TYPE

PATTERNS

Patterns feature illuminated corners and angles. **Must consult factory for custom corners and patterns.**

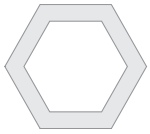
Square Patterns

X Patterns



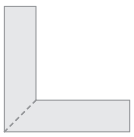
T Patterns

Custom Angles



Custom Patterns

LENS CUT



Mitered

Updated: 07/21/2020

CORONET, Inc.
55 Shepherds Lane
Totowa, NJ 07512

T 973 345 7660
F 973 345 8705

CORONET, Inc. reserves the right to make any design changes for continuous improvement which will not affect the overall appearance or performance.

WWW.CORONETLED.COM

3/3

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Manufacturer: CORONET : LSR2 LED LTG1
Description: Recessed Linear

Fixture Wattage: 60 W
Lumen Output: 5400 lumen
Lamp CRI: 90+
Lighting Controls: 0-10V Dimming

Voltage: 120 V
Fixture Finish: Anodized Aluminum
Lamp CCT: 4000K
Assembly Code: LSR2 LED 8 40 LTG1 UNV DB1% CC F SD

Type: AL13

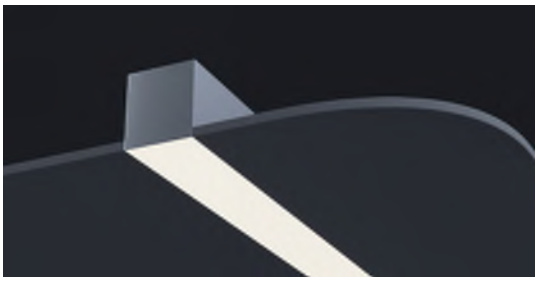
Lighting Notes:

1. Contractor to verify mounting type compatibility with ceiling type.

Coronet

LSR2 LED

DATE	PROJECT	FIRM	TYPE



Narrow, recessed, architectural luminaire with semi-recessed lens (protrudes 3/8" from ceiling). For use in indoor applications where an LED luminaire with small profile providing continuous light is required. Suitable for grid systems or drywall installation as well as custom mounting requests.

FEATURES

- Available In Made To Measure Lengths Accurate Up To 1/16"
- Patterns Available (See Page 3)
- Damp Location Rated
- CRI 90+ Standard; R9>50
- 5 Year, 50,000 Hour Fixture Warranty
- 2700K, 3000K, 3500K, 4000K & 5000K Color Temperatures Available
- Available with PoE

APPLICATIONS Offices, Lobbies, Retail Stores, Classrooms, Reception Areas & Corridors

CONSTRUCTION Extruded Aluminum Housing with Steel End Caps. Formed Steel Gear Tray

OPTICS Extruded High Transmission Satin Acrylic Lens with No LED Imaging. Flat Lens Optional

WARRANTY 5 Year Limited Warranty (Covers Standard Components)

FINISH Standard Powder-Coated White. Custom RAL Colors Available

FIXTURE RATINGS & CERTIFICATIONS Union Made, Made In The USA, ETL Listed, Damp Location Rated

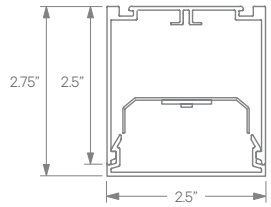
*Must Specify JA8 Compliant Driver

ELECTRICAL Integral Driver with 0-10V Dimming Standard. Several Driver Options Available

DRIVERS & SENSORS

For Wiring Diagrams and Sensor Information Click Here

EXTRUSION DIMENSIONS



NOTE: STANDARD LENS SITS 1/4" BELOW EXTRUDED HOUSING. FLUSH LENS OPTION AVAILABLE.

LED SYSTEM INFORMATION

	Nominal System Watts	Nominal Delivered Lumens	Nominal Efficacy
Standard (LTG1)	7.25 W/ft	675 lm/ft	94 LPW
Low (LTG2)	5 W/ft	508 lm/ft	95 LPW
High (LTG3)	10 W/ft	914 lm/ft	92 LPW

Based on a 3500K luminaire using one driver. Custom outputs available; specify below.

ORDERING

1	2	3	4	5	6	7	8	9	10	11	12

1 - FIXTURE ID
LSR2 LED

2 - LENGTH
2 - 2 ft
4 - 4 ft
8 - 8 ft
X'-X" - Specify Length
PAT - Pattern (Consult Factory)

3 - COLOR TEMP
27 - 2700K/90 CRI
30 - 3000K/90 CRI
35 - 3500K/90 CRI
40 - 4000K/90 CRI
50 - 5000K/90 CRI
TW* - Tunable White
RGBW** - RGB+3000K
*Must use DMX or TW10 Driver
**Must use DMX Driver

4 - LED SYSTEM
LTG1 - Standard
LTG2 - Low
LTG3 - High
LTGC - Custom Output

5 - VOLTAGE
UNV - Universal (120/277V)

6 - DRIVER
DB - Standard Dimming (0-10V)
DB1% - 1% Dimming (0-10V)
DB.1% - 0.1% Dimming (0-10V)
LTEA - Lutron 2-wire 1% Dimming (120V only)
LDE1 - Lutron Digital EcoSystem
LDE5 - 5 Series EcoSystem; 5% Dimming
JA8 - JA8 Compliant 1% Dimming (0-10V)
PoE - Power over Ethernet. Consult Factory for Compatibility
DMX - For Color Tuning and RGBW (Remote)
TW10 - Dual Channel, 0-10V For Color Tuning (CCT and Intensity Control)

7 - FINISH
W - White (Standard)
CC - Custom Color (provide RAL#)

8 - MOUNTING
T - 9/16" Tee Grid
T15 - 15/16" Tee Grid
SG - Slot Grid/Interlude
F - Flange
NT - No Trim/Spackle Flange
PM-X* - Perimeter Mount
*"X" denotes mounting type on opposite side of wall (ie-**PM-NT**). Consult Factory

9 - OPTICS
SD - Standard Diffuser
FL - Flat Lens

10 - CONTROL (Optional)
EIS - Enlighted Sensor
WISD - Wattstopper Daylight Sensor
WISM - Wattstopper Occupancy Sensor
SLS - SensiLUM Sensor
ACS - Acuity Controls nLight System
CCS - Casambi Compatible
ECS - Eaton WaveLinx System
*For other control systems not listed consult factory.

11 - CIRCUIT (Optional)
EM 120V - Emergency Pack
EM 277V - Emergency Pack

11 - OTHER OPTIONS
WH6 - 6ft Whips Preinstalled
CP - Chicago Plenum

Updated: 07/21/2020

CORONET, Inc.
55 Shepherds Lane
Totowa, NJ 07512

T 973 345 7660
F 973 345 8705

CORONET, Inc. reserves the right to make any design changes for continuous improvement which will not affect the overall appearance or performance.

WWW.CORONETLED.COM

1/3

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Coronet

LSR2 LED

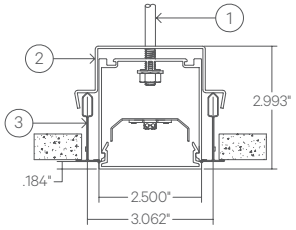
Type: AL13

Page 2 of 3

DATE	PROJECT	FIRM	TYPE

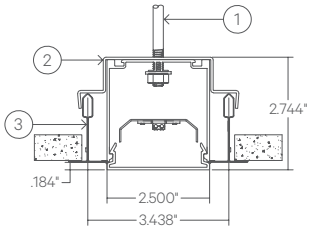
MOUNTING OPTIONS

T - 9/16" Tee Grid



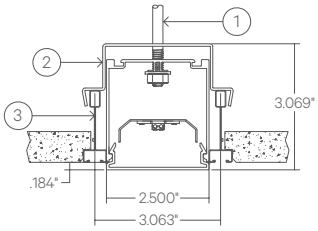
1 - Threaded Rod (not supplied)
2 - Tee Grid Bracket
3 - Tee Grid

T15 - 15/16" Tee Grid



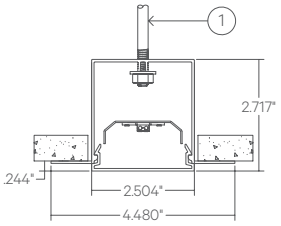
1 - Threaded Rod (not supplied)
2 - Tee Grid Bracket
3 - Tee Grid

SG - Slot Grid/Interlude



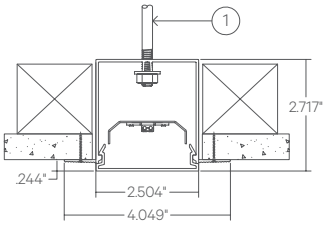
1 - Threaded Rod (not supplied)
2 - Slot Grid Bracket
3 - Slot Grid

F - Flange



1 - Threaded Rod (not supplied)

NT - No Trim/Spackle Flange



1 - Threaded Rod (not supplied)

Updated: 07/21/2020

CORONET, Inc.
55 Shepherds Lane
Totowa, NJ 07512

T 973 345 7660
F 973 345 8705

CORONET, Inc. reserves the right to make any design changes for continuous improvement which will not affect the overall appearance or performance.

WWW.CORONETLED.COM

2/3

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Coronet

LSR2 LED

Type: AL13

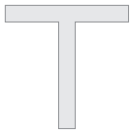
DATE	PROJECT	FIRM	TYPE

PATTERNS

Patterns feature illuminated corners and angles. **Must consult factory for custom corners and patterns.**

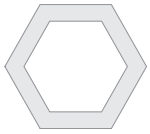
Square Patterns

X Patterns



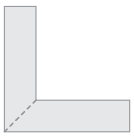
T Patterns

Custom Angles



Custom Patterns

LENS CUT



Mitered

Updated: 07/21/2020

CORONET, Inc.
55 Shepherds Lane
Totowa, NJ 07512

T 973 345 7660
F 973 345 8705

CORONET, Inc. reserves the right to make any design changes for continuous improvement which will not affect the overall appearance or performance.

WWW.CORONETLED.COM

3/3

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Manufacturer: iGuzzini : Palco In Out
Description: Description

Fixture Wattage: 16 W
Lumen Output: 1806 lumen
Lamp CRI: 80+
Lighting Controls: 0-10V Dimming

Voltage: 48 V
Fixture Finish: Grey
Lamp CCT: 4000K
Assembly Code: Q719

Palco InOut

Design Artec3 Studio iGuzzini

Last information update: September 2020

Product configuration: Q719
Q719: Spotlight with base - Warm White Led - Class III - Very Wide Flood optic

Product code
Q719: Spotlight with base - Warm White Led - Class III - Very Wide Flood optic

Technical description
Spotlight designed to use LED lamps and a Very Wide Flood optic. The optical assembly and base is made of EN1706AC 46100LF aluminium alloy and subjected to a multi-step, pre-treatment process, in which the main phases are degreasing, fluorozirconation (a protective surface film) and sealing (with a nano-structured silane layer). The following painting stage consists of a primer and a liquid acrylic paint, cured at 150°C, with a high level of weather and UV ray resistance. 5 mm thick tempered sodium-calcium closing glass. Double adjustability allows a 360° rotation about the vertical axis and 90° tilting relative to the horizontal plane. Mechanical aiming locks for rotation on both the vertical axis and horizontal plane. Complete with a monochrome LED circuit and an Opti Beam Reflector optic system. The product includes a PG13.5 cable gland. Black rubber outlet cable complete with anti-transpiration device. Black rubber outlet cable complete with anti-transpiration device. Electronic ballast to be ordered separately. Option of using optic accessories assembled via an accessory holder frame. All external screws used are made of A2 stainless steel.

Installation
Floor, wall, ceiling or ground-installed via a stake.

Colour	**Weight (Kg)**
White (01) | Grey (15)	1.3

Mounting
wall surface|ground spike

Wiring
The product is supplied with a black rubber outlet cable complete with anti-transpiration device L=1000mm.

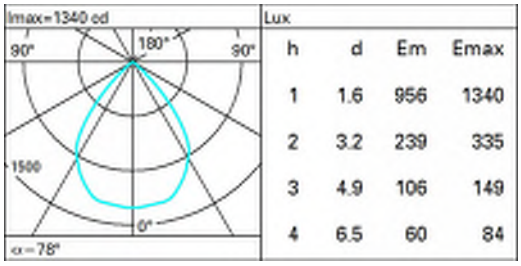
Complies with EN60598-1 and pertinent regulations

IK07 IP66

Technical data

lm system:	1806	MacAdam Step:	2
W system:	16	Life Time LED 1:	100,000h - L80 - B10 (Ta 25°C)
lm source:	2150	Ballast losses [W]:	0
W source:	16	Lamp code:	LED
Luminous efficiency (lm/W, real value):	112.9	Number of lamps for optical assembly:	1
lm in emergency mode:	-	ZVEI Code:	LED
Total light flux at or above an angle of 90° [Lm]:	0	Number of optical assemblies:	1
Light Output Ratio (L.O.R.) [%]:	84	Ambient operating temperature range:	from -30°C to 35°C.
Beam angle [°]:	78°	Lifetime of product at ambient operating temperature:	≥ 50.000h Ta=25°C
CRI:	80		
Colour temperature [K]:	3000	LED Currente:	470

Polar



Q719_EN 1 / 2

Type:
AWS04

Lighting Notes:

1. Contractor to coordinate mounting with architect.
2. Contractor to coordinate with architect and lighting consultant for final aiming and focus for adjustable fixtures.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Isolux

UGR diagram

Corrected UGR values (at 2750 lm bare lamp luminous flux)

Reflect.: ceil/cav		0.70	0.70	0.50	0.50	0.30	0.70	0.70	0.50	0.50	0.30
walls		0.50	0.30	0.50	0.30	0.30	0.50	0.30	0.50	0.30	0.30
work pl.		0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Room dim.				viewed crosswise					viewed endwise		
x	y										
2H	2H	28.1	28.9	28.4	27.1	27.3	28.1	28.9	28.4	27.1	27.3
	3H	28.0	28.6	28.3	26.9	27.2	28.0	28.6	28.3	26.9	27.2
	4H	25.9	28.5	28.2	26.8	27.1	25.9	28.5	28.2	26.8	27.1
	6H	25.8	28.4	28.2	26.7	27.0	25.8	28.4	28.2	26.7	27.0
	8H	25.8	28.3	28.2	26.7	27.0	25.8	28.3	28.2	26.7	27.0
	12H	25.8	28.3	28.1	26.6	27.0	25.8	28.3	28.1	26.6	27.0
4H	2H	25.9	28.5	28.2	26.8	27.1	25.9	28.5	28.2	26.8	27.1
	3H	25.8	28.3	28.1	26.6	27.0	25.8	28.3	28.1	26.6	27.0
	4H	25.7	28.1	28.1	26.5	26.9	25.7	28.1	28.1	26.5	26.8
	6H	25.6	28.0	28.0	26.4	26.8	25.6	28.0	28.0	26.4	26.8
	8H	25.5	25.9	28.0	26.3	26.7	25.5	25.9	28.0	26.3	26.7
	12H	25.5	25.8	25.9	26.2	26.7	25.5	25.8	25.9	26.2	26.7
6H	4H	25.5	25.9	28.0	26.3	26.7	25.5	25.9	28.0	26.3	26.7
	6H	25.4	25.7	25.9	26.2	26.7	25.4	25.7	25.9	26.2	26.7
	8H	25.4	25.6	25.9	26.1	26.6	25.4	25.6	25.9	26.1	26.6
	12H	25.3	25.6	25.8	26.0	26.6	25.3	25.6	25.8	26.0	26.6
12H	4H	25.5	25.8	25.9	26.2	26.7	25.5	25.8	25.9	26.2	26.7
	6H	25.4	25.6	25.9	26.1	26.6	25.4	25.6	25.9	26.1	26.6
	8H	25.3	25.6	25.8	26.0	26.6	25.3	25.6	25.8	26.0	26.6

Variations with the observer position at spacing:

S =			
	1.0H	-3.2 / -16.6	-3.2 / -16.6
	1.5H	-5.5 / -23.3	-5.5 / -23.3
	2.0H	-7.5 / -25.3	-7.5 / -25.3

Q719_EN 2 / 2

Type:

AWS04

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Manufacturer: iGuzzini : Palco In Out
Description: Description

Fixture Wattage: 80 W
Lumen Output: 8585 lumen
Lamp CRI: 80+
Lighting Controls: 0-10V Dimming

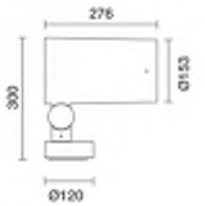
Voltage: 120 V
Fixture Finish: Grey
Lamp CCT: 4000K
Assembly Code: ES89

Palco InOut

Design Artec3 Studio — iGuzzini

Last information update: October 2020

Product configuration: ES89
ES89: Spotlight with base - Neutral White Led - integrated electronic control gear - H.O. - Ta 25



Product code
ES89: Spotlight with base - Neutral White Led - integrated electronic control gear - H.O. - Ta 25

Technical description
Spotlight designed to use LED lamps and a Wide Flood optic. The optical assembly and base is made of EN1706AC 46100LF aluminium alloy and subjected to a multi-step, pre-treatment process, in which the main phases are degreasing, fluorozirconation (a protective surface film) and sealing (with a nano-structured silane layer). The following painting stage consists of a primer and a liquid acrylic paint, cured at 150°C, with a high level of weather and UV ray resistance. 5 mm thick tempered sodium-calcium closing glass. Double adjustability allows a 360° rotation about the vertical axis and 90° tilting relative to the horizontal plane. Mechanical aiming locks for rotation on both the vertical axis and horizontal plane. Complete with a monochrome LED circuit and an Opti Beam Reflector optic system. The product includes a PG13.5 cable gland. Electronic DALI ballast integrated in product. Option of using optic accessories assembled via an accessory holder frame. All external screws used are made of A2 stainless steel.

Installation
Floor, wall, ceiling or ground-installed via a stake.

Colour	**Weight (Kg)**
White (01) | Grey (15)	6.56

Mounting
wall arm|ground surface|wall surface|ceiling surface

Wiring
Double PG.

Complies with EN60598-1 and pertinent regulations

IK07 IP66

Technical data

Im system:	8585	Life Time LED 1:	48,000h - L80 - B10 (Ta 25°C)
W system:	80.6	Ballast losses [W]:	9.6
Im source:	10100	Voltage [Vin]:	230
W source:	71	Lamp code:	LED
Luminous efficiency (lm/W, real value):	106.5	Number of lamps for optical assembly:	1
Im in emergency mode:	-	ZVEI Code:	LED
Total light flux at or above an angle of 90° [Lm]:	0	Number of optical assemblies:	1
Light Output Ratio (L.O.R.) [%]:	85	Ambient operating temperature range:	from -30°C to 35°C.
Beam angle [°]:	79°	Power factor:	See installation instructions
CRI:	80	Overvoltage protection:	10kV Common mode & 6kV Differential mode
Colour temperature [K]:	4000	Dimming mode:	CCR
MacAdam Step:	3	Control:	DALI

ES89_EN 1 / 2

Type:
AWS05

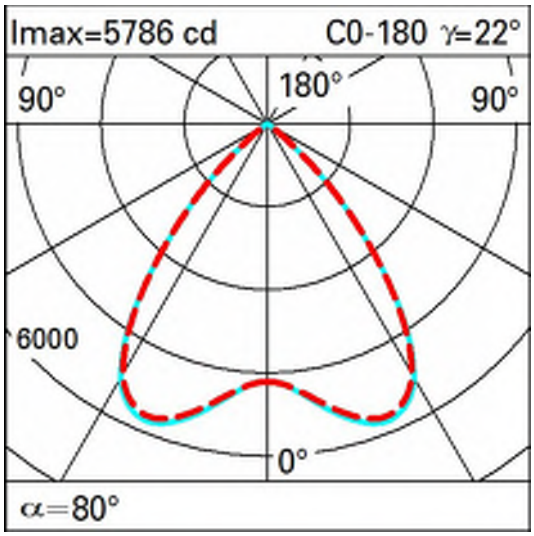
Lighting Notes:

1. Contractor to coordinate mounting with architect.
2. Contractor to coordinate with architect and lighting consultant for final aiming and focus for adjustable fixtures.

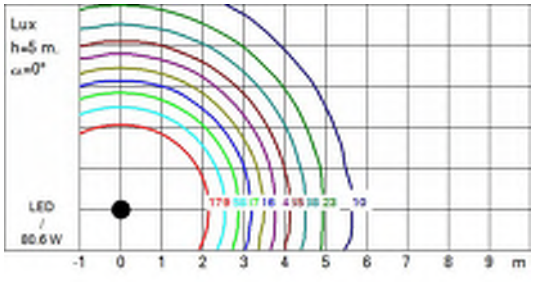
ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:
AWS05

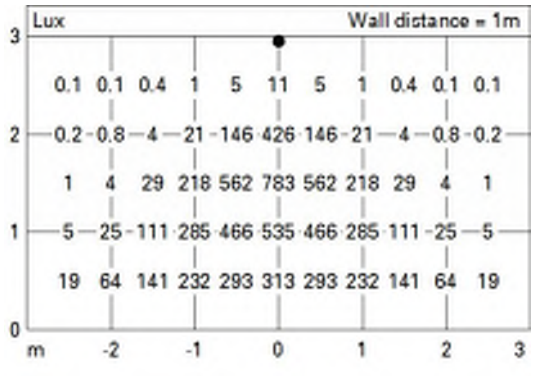
Polar



Isolux



Illuminances



ES89_EN 2 / 2

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Manufacturer: LITHONIA LIGHTING : ZL1N
Description: Suspended Linear

Fixture Wattage: 25 W
Lumen Output: 2728 lumen
Lamp CRI: 90+
Lighting Controls: 0-10V Dimming

Voltage: 120 V
Fixture Finish: Anodized Aluminum
Lamp CCT: 4000K
Assembly Code: ZL1N-L48-SMR-3000LM-SBL FST-120-40K-90CRI-ZACVH

LITHONIA LIGHTING®

FEATURES & SPECIFICATIONS

INTENDED USE — Built on the compact, low-profile Z strip channel, this LED strip offers long maintenance-free life, several color temperatures, lumen outputs and lengths. Ideal for new construction and retrofit applications in T5 and T8 lengths. Ideal for uplight and downlight in commercial, retail, manufacturing, warehouse, cove and display applications. **Certain airborne contaminants can diminish the integrity of acrylic and/or polycarbonate.** Click here for Acrylic-Polycarbonate Compatibility table for suitable uses.

CONSTRUCTION — Compact-design channel and cover are formed from code-gauge cold-rolled steel. Easy to install row aligner included for continuous row mounting.

Finish: Paint options include high-gloss, baked white enamel (WH), galvanized (GALV), matte black (MB) and smoke gray (SKGY). After fabrication, five-stage iron phosphate pre-treatment ensures superior paint adhesion and rust resistance.

OPTICS — Standard diffuse snap on/snap off lens eliminates pixels, improves uniformity and minimizes glare. L/LENS option available.

ELECTRICAL — L70>60,000hours. Utilizes high-output LEDs integrated on a two-layer circuit board, ensuring cool-running operation. Optional internal pluggable wiring harness for reduced labor cost in row mounting applications. (See PLR_ ordering information on page 3.) Electronic LED driver is rated for 75 input watts maximum (see Operational Data on page two for actual wattage consumption), **multi-volt input and 0-10V dimming standard**. This fixture is designed to withstand a maximum line surge of 2.5kV at 0.75kA combination wave for indoor locations, for applications requiring higher level of protection additional surge protection must be provided.

LEDs provide nominal 80 CRI at 3000 K, 3500 K,4000 K, or 5000 K.

Lumen output up to 2,000 lumens per foot. In 86°F (30°C) ambient environments. Luminaire should be installed in applications where ambient temperatures do not exceed 86°F (30°C).

INSTALLATION — Tool-less channel cover for easy installation.

Fixture may be surface mounted (with or without ZSPRG hanger), pendant or stem mounted with appropriate mounting options. Three-point aligner locks in place for easy continuous row mounting.

LISTINGS — CSA certified to US and Canadian safety standards. For use in damp locations between -40°F (-40°C) and 86°F (30°C).

DesignLights Consortium® (DLC) qualified product. Not all versions of this product may be DLC qualified. Please check the DLC Qualified Products List at www.designlights.org to confirm which versions are qualified.

WARRANTY — 5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/support/customer-support/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application.

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

Catalog Number
Notes
Type

LED Striplight

ZL1N

24", 48" and 96" Lengths

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® or XPoint™ Wireless control networks marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

INDUSTRIAL

ZL1N
Page 1 of 6

Type:
AL02b

Page 1 of 6

Lighting Notes:

1. Mounting to be coordinated with architect.
2. Mounting and installation of conduit and routing path to be coordinated with architect.
3. Coordinate suspension length according to architectural drawings.
4. Provide suspension accessories: AIRCRAFT CABLE

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:
AL02b
Page 2 of 6

ZL1N LED Striplight

A+ Capable options indicated by this color background.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: ZL1N L48 3000LM FST MVOLT 40K 80CRI WH

Series		Length		Reflectors[2]		Nominal lumens[3]		Diffuser		Voltage	
ZL1N	LED striplight	L24	24"[1]	(blank)	Less reflector	1500LM	1,500 lumens	FST	Snap on frosted, diffuse	MVOLT	120-277V
				SMR	Symmetric	2500LM	2,500 lumens	L/LENS	No diffuser	120	120V
						3500LM	3,500 lumens	SBL FST	Straight blade louver with snap on frosted, diffuse	208	208V
		L46	46"	(blank)	Less reflector	3000LM	3,000 lumens			240	240V
		L48	48"	ASR	Asymmetric (L48 only)	5000LM	5,000 lumens			277	277V
				SMR	Symmetric	7000LM	7,000 lumens			347	347V[4]
TZL1N	LED striplight	L92	92"	(blank)	Less reflector	6000LM	6,000 lumens			480	480V[4]
		L96	96"	SMR	Symmetric	10000LM	10,000 lumens				
						14000LM	14,000 lumens				

Color temperature		Color rendering index		Options			Paint finish	
30K	3000 K	80CRI	80 CRI	PLR___	Plug-in wiring[5,6]	**Individual Controls**[5]	WH	White
35K	3500 K	90CRI	90 CRI	PLR1LVG	Plug-in wiring-low voltage[5,6]	LBOZU 360° low mount motion sensor, pre-wired[10]	GALV	Galvanized
40K	4000 K			E7W	Emergency battery pack, 7W CA Title 20 Noncompliant[7]	LBH0SZU 360° low mount motion sensor with dimming, pre-wired[10]	MB	Matte black
50K	5000 K			2E7W	Two Emergency battery packs, 7W CA Title 20 Noncompliant[7,8]	LBPZU 360° low mount motion sensor with photocell, pre-wired[10]	SKGY	Smoke gray
				E10WLCP	Emergency battery pack, 10W Linear Constant Power, Certified in CA Title 20 MAEDBS[7]	LBM0SZU 360° low mount motion sensor, dimming & switching photocell, pre-wired[10]		
				2E10WLCP	Two Emergency battery packs, 10W Linear Constant Power, Certified in CA Title 20 MAEDBS[7,8]	**Cord sets:**[11]		
				E15WLCP	Emergency battery pack, 15W Linear Constant Power, Certified in CA Title 20 MAEDBS[7,8]	CS1W Straight plug, 120V		
				OUTEND	Cord set to exit endplate of fixture	CS3W Twist-lock, 120V		
				Wireless Controls[5]		CS7W Straight plug, 277V		
				NLTAIR2 RLSXR10	nLight Air Generation 2 Fixture mount, LSXR sensor low mount 360˚	CS11W Twist-lock, 277V		
				NLTAIR2 RLSXR10EM	nLight Air Generation 2 Fixture mount, LSXR sensor low mount 360˚, UL924 Emergency operation[9]	CS25W Twist-lock, 347V		
						CS97W Twist-lock, 480V		
						CS93W 600V SEOOW white cord, no plug (no voltage required)		

Accessories: *Order as separate catalog number.*

HC36	Hanger chain, 36"	ZLR L24 SYM WH	24" symmetric reflector, white finish
ZACVH	Aircraft cable 10' (one pair)	ZLR L46 SYM UPL WH	46" symmetric reflector with uplight, white finish
ZLANGBKT	Luma-tilt™ angle bracket for shelf or ledge mounting only	ZLR L46 SYM WH	46" symmetric reflector, white finish
SQ_	Stem kit, 2" increments up to 48"	ZLR L48 ASY WH	48" asymmetric reflector, white finish
NPP16D	nLight® switching/dimming module	ZLR L48 SYM UPL WH	48" symmetric reflector with uplight, white finish
rPP20D	nLight® Air switching/dimming module	ZLR L48 SYM WH	48" symmetric reflector, white finish
LSXR	Sensor Switch® LSXR occupancy sensor[4]	ZLR L92 SYM UPL WH	92" symmetric reflector with uplight, white finish
ZSPRG	For 15/16" T-grid only	ZLR L92 SYM WH	92" symmetric reflector, white finish
WGZ24	24" wireguard, white[12]	ZLR L96 SYM UPL WH	96" symmetric reflector with uplight, white finish
WGZ48	48" wireguard, white[12,13]	ZLR L96 SYM WH	96" symmetric reflector, white finish
ZLR L24 SYM UPL WH	24" symmetric reflector with uplight, white finish	UNIVERSAL REFL ALIGNER	Universal reflector aligners, quantity 1

Notes

1 Not available with 347V, 480V or Batteries
2 Optional. Reflectors ship separately.
3 See Operational Data on page 2 for actual lumens.
4 Utilizes step down transformer.
5 See ordering information on pages 4 and 5 and rLSXR specification sheet for more configurations. When choosing Sensor and PLR for same fixture, consult the factory.
6 Not available with cord sets.
7 MVOLT only. Not available with cord sets with plugs. Battery Spec sheet linked for more information.
8 Only available with 10,000LM and 14,000LM packages.
9 MVOLT only.
10 Available with MVOLT, 347V and 480V only. This sensor configuration is suitable for minimum ambient temperature of 14°F (-10°C). See page 6 for low temperature option providing -4°F (-20°C) minimum ambient Sensors come prewired, they must be snapped into place at time of installation.
11 Cordsets exit back of fixture unless OUTEND option is specified. Must specify voltage (not required when ordering CS93W).
12 Not compatible with reflector
13 Order 2 for tandem double length fixtures (TZL1N).

ARUP
Project Number: 271565
Phone: 1 212 896 3000

ZL1N LED Striplight

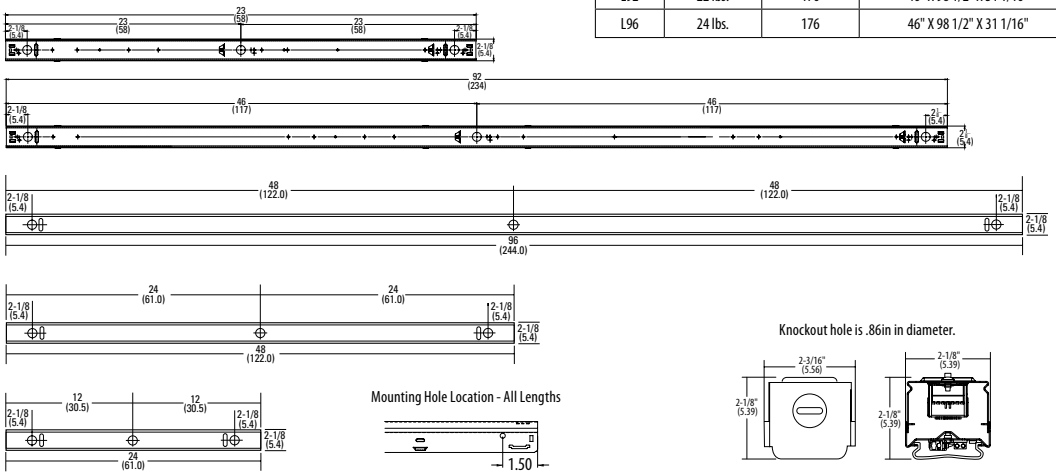
Type:
AL02b
Page 3 of 6

OPERATIONAL DATA												
	Nominal lumen package	Length (inches)	Delivered Lumens 3000 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 3500 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 4000 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 5000 K CCT @ 77°F (25°C) ambient temperature		Wattage @ 120V/277V	Comparable Light Source
			80 CRI	90 CRI	80 CRI	90 CRI	80 CRI	90 CRI	80 CRI	90 CRI		
Lensed	1500LM	24	1738	1409	1777	1467	1804	1494	1871	1528	15	1-lamp 17W T8
	2500LM	24	2265	1846	2315	1900	2351	1947	2438	1991	19	1-lamp 17W T8
	3500LM	24	3586	2924	3666	3026	3723	3084	3860	3152	31	1-lamp 32W T8, 1-lamp 54W T5H0, 50W HID
	3000LM	46 or 48	3172	2586	3243	2677	3293	2728	3415	2788	25	1-lamp 32W T8, 1-lamp 54W T5H0, 50W HID
	5000LM	46 or 48	4417	3601	4515	3727	4585	3798	4754	3882	34	2-lamp 32W T8, 1-lamp 54W T5H0, 70W HID
	7000LM	46 or 48	6535	5328	6681	5515	6785	5619	7035	5744	52	3-lamp 32W T8, 2-lamp 54W T5H0, 100W HID
	6000LM	92 or 96	6561	5349	6708	5537	6812	5642	7063	5767	48	3-lamp 32W T8, 2-lamp 54W T5H0, 100W HID
	10000LM	92 or 96	8687	7082	8881	7331	9019	7470	9351	7636	68	4-lamp 32W T8, 2-lamp 54W T5H0, 100W HID
	14000LM	92 or 96	12457	10513	12735	10665	12933	10711	13409	10949	104	4-lamp 32W T8, 3-lamp 54W T5H0, 150W HID
Unlensed	1500LM	24	1881	1534	1923	1588	1953	1618	2025	1654	15	1-lamp 17W T8
	2500LM	24	2452	1999	2506	2069	2545	2108	2639	2155	19	1-lamp 17W T8
	3500LM	24	3882	3165	3969	3276	4031	3338	4179	3412	31	1-lamp 32W T8, 1-lamp 54W T5H0, 50W HID
	3000LM	46 or 48	3434	2800	3511	2898	3565	2953	3697	3019	25	1-lamp 32W T8, 1-lamp 54W T5H0, 50W HID
	5000LM	46 or 48	4781	3898	4888	4035	4964	4111	5147	4203	34	2-lamp 32W T8, 1-lamp 54W T5H0, 70W HID
	7000LM	46 or 48	7075	5768	7233	5971	7345	6083	7616	6219	52	3-lamp 32W T8, 2-lamp 54W T5H0, 100W HID
	6000LM	92 or 96	7103	5791	7261	5995	7374	6108	7646	6243	48	3-lamp 32W T8, 2-lamp 54W T5H0, 100W HID
	10000LM	92 or 96	9404	7667	9614	7937	9764	8087	10123	8266	68	4-lamp 32W T8, 2-lamp 54W T5H0, 100W HID
	14000LM	92 or 96	13485	10994	13786	11381	14001	11596	14516	11853	104	4-lamp 32W T8, 3-lamp 54W T5H0, 150W HID

DIMENSIONS

All dimensions are shown in inches (centimeters) unless otherwise noted.
Specifications subject to change without notice.

PALLET DIMENSIONS			
Length	Approximate weight	Fixtures per pallet	Approximate pallet dimensions (L x W x H)
L24	7 lbs.	408	46" X 51" X 32 11/16"
L46	11 lbs.	176	46" X 51" X 32 1/16"
L48	12 lbs.	176	46" X 51" X 31 3/8"
L92	22 lbs.	176	46" X 98 1/2" X 31 1/16"
L96	24 lbs.	176	46" X 98 1/2" X 31 1/16"



Mounting Hole Location - All Lengths

Knockout hole is .86in in diameter.

PHOTOMETRICS

Please see www.lithonia.com

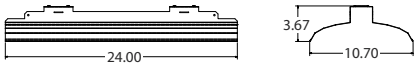
ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:
AL02b
Page 4 of 6

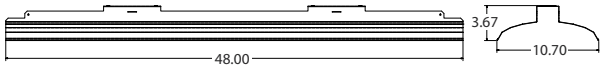
ZL1N LED Striplight

REFLECTORS (Optional)

L24 Reflector



L48 Reflector



L96 Reflector

PHOTOMETRICS

Please see www.lithonia.com

PRODUCT INFORMATION

Advanced plug-in system with two-circuit capability. Available on industrial and strip products and a variety of architectural products mounted in continuous rows. 1, 2, 3 and 4-lamp fixtures. PLR22 (2-circuit) and crossover harness switches hot circuit serving next fixture in row. Reduces fixture types on job for alternating circuit applications (see example below.)

Easy one-step installation, saves up to 35% on labor costs. Expanded switching flexibility helps save energy.

Rows can be 50% longer with two-circuit systems. Polarized, lock-together nylon connectors prevent miswiring in the field. #12 THHN conductor, rated 600V, 90°C. White neutral wire included. Grounding accomplished by fixture in-row connectors.

CSA certified systems available with up to 2 circuits. G ground required.

Note: Specifications subject to change without notice.

Wiring

PLR

Advanced 1 or 2-Circuit Plug-In

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Series	Number of hot wires	Branch circuits		Dimming	Ground
PLR	(blank) Not required for 22	Circuits to which ballast is connected	Emergency circuit connected	LV Low-voltage dimming	G Ground, required
PLR22	1 Black	(blank) Not required for 22 or PLR1	(blank) No emergency circuit		
	2 Black and red	A Black wire	ELA Emergency circuit wired to black wire		
		B Red wire	ELB Emergency circuit wired to red wire		

Typical Applications

- Multiple-circuit and single-circuit for longer continuous rows
- Multiple-circuit with alternating fixtures on separate circuits, 2-circuit (PLR 22)
- Multiple circuit with night-lights located along row as desired

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:
AL02b
Page 5 of 6

ZL1N LED Striplight

LSXR – Fixture Mount Occupancy Sensor (see www.AcuityControls.com for additional information)

- Three interchangeable lens options to satisfy multiple mounting heights and coverage pattern requirements.
- Integrated mounting bracket drops lens down 3" from chase nipple.
- Single or dual relay versions — designed with robust protection from the harsh switching requirements of T5 and LED loads.
- Photocell and 0-10VDC dimming options.
- No PIR field calibration or sensitivity adjustments required.
- Sensor ambient temperature rating of 14°F (-10°C) to 131°F (55°C).

LSXR configuration	Comparable CMRB sensor	Old style sensor nomenclature
For shortest lead times use one of the following LSXR configurations		
LCOZU	CMRB 50	MSI
LCH0SZU	CMRB 50 D	MSID
LCPZU	CMRB 50 P	MSIPED
LAOZU	CMRB 6	MSI360
LAH0SZU	CMRB 6 D	MSI360D
LAPZU	CMRB 6 P	MSI360PED

SELECTIONS BELOW WILL EXTEND ORDER LEAD TIME. CONSULT YOUR SALES REPRESENTATIVE FOR DETAILS.

SINGLE RELAY

ORDERING INFORMATION

Example: LAH0SZU

Series	Lens option	Dimming/Photocell	Max. dim level	Min. dim level	Temp/Humidity	Default occupancy time delay
L LSXR passive infrared indoor occupancy sensor	A High mount, 360° B Low mount, 360° C High mount aisleway	0 None[1] H High/low occupancy operation P Switching photocell (on/off)[1] M Dimming and switching photocell G Dimming and switching photocell with high/low occupancy operation	0 10 VDC 9 9 VDC 8 8 VDC 7 7 VDC	S Minimum dim level of ballast 1 1 VDC 2 2 VDC 3 3 VDC 4 4 VDC 5 5 VDC 6 6 VDC	Z None T Low temperature[2]	I 30 sec D 2.5 min X 5.0 min R 7.5 min U 10.0 min (with minimum 15 minute on time) V 15.0 min W 20.0 min Y 30.0 min

Notes

1 Max and min dim levels not applicable with this option.

2 Ambient temperature rating of -4°F (-20°C) to 131°F (55°C).

DUAL RELAY (Available with 120, 277, and 347V only)

ORDERING INFORMATION

Example: LA2KZU

Series	Lens option	Poles	Operating mode	Temp/Humidity	Default occupancy time delay
L LSXR passive infrared indoor occupancy sensor	A High mount, 360° B Low mount, 360° C High mount aisleway	2 Dual relay	J None K Alternating off relays (promotes even lamp wear) O Alternating off relays w/photocell P Switching photocell(on/off) E Photocell on/off (pole 1 only) F Photocell on/off - both poles (dual set-point)	Z None T Low temperature[1]	I 30 sec D 2.5 min X 5.0 min R 7.5 min U 10.0 min (with minimum 15 minute on time) V 15.0 min W 20.0 min Y 30.0 min

Notes

1 Ambient temperature rating of -4°F (-20°C) to 131°F (55°C).

Example: LENS 50 J100

Replacement lenses: *Order as separate catalog number.*

Series	Lens type	Package quantity
LENS	6 High mount 360° 10 Low mount 360° 50 High mount aisleway	[blank] Single Lens J10 10-pack J100 100-pack

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:
AL02b
Page 6 of 6

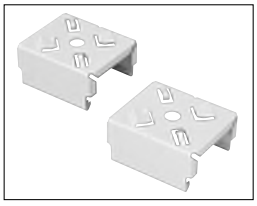
ZL1N LED Striplight

OPTIONS AND ACCESSORIES

The Z Series fixture offers numerous options for almost every electrical and optical component, including a long list of field-installable accessories.

HANGER CHAIN
36" chain with Y hanger.

Order as:
HC36



Z SPRING HANGER
Snap 'n' lock design requires no fasteners and can be used on T-grid ceiling or universal mounting systems.

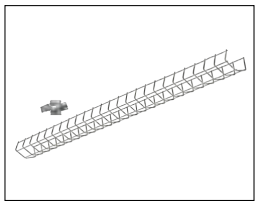
Order as:
ZSPRG

ZACVH HANGER
10' Aircraft cable with Y hanger.

Order as:
ZACVH

ANGLE MOUNTING BRACKET
Luma-tilt™ angle bracket ships as a pair

Order as:
ZLANGBKT



WIRE GUARD

Order as:
WGZ24
WGZ48

© 2013-2020 Acuity Brands Lighting, Inc. All rights reserved.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Manufacturer: LITHONIA LIGHTING : ZL1N
Description: Suspended Linear

Fixture Wattage: 48 W
Lumen Output: 5642 lumen
Lamp CRI: 90+
Lighting Controls: 0-10V Dimming

Voltage: 120 V
Fixture Finish: Anodized Aluminum
Lamp CCT: 4000K
Assembly Code: ZL1N-L96-SMR-6000LM-SBL FST-120-40K-90CRI-ZACVH

LITHONIA LIGHTING®

FEATURES & SPECIFICATIONS

INTENDED USE — Built on the compact, low-profile Z strip channel, this LED strip offers long maintenance-free life, several color temperatures, lumen outputs and lengths. Ideal for new construction and retrofit applications in T5 and T8 lengths. Ideal for uplight and downlight in commercial, retail, manufacturing, warehouse, cove and display applications. **Certain airborne contaminants can diminish the integrity of acrylic and/or polycarbonate.** Click here for Acrylic-Polycarbonate Compatibility table for suitable uses.

CONSTRUCTION — Compact-design channel and cover are formed from code-gauge cold-rolled steel. Easy to install row aligner included for continuous row mounting.

Finish: Paint options include high-gloss, baked white enamel (WH), galvanized (GALV), matte black (MB) and smoke gray (SKGY). After fabrication, five-stage iron phosphate pre-treatment ensures superior paint adhesion and rust resistance.

OPTICS — Standard diffuse snap on/snap off lens eliminates pixels, improves uniformity and minimizes glare. L/LENS option available.

ELECTRICAL — L70>60,000hours. Utilizes high-output LEDs integrated on a two-layer circuit board, ensuring cool-running operation. Optional internal pluggable wiring harness for reduced labor cost in row mounting applications. (See PLR_ ordering information on page 3.) Electronic LED driver is rated for 75 input watts maximum (see Operational Data on page two for actual wattage consumption), **multi-volt input and 0-10V dimming standard**. This fixture is designed to withstand a maximum line surge of 2.5kV at 0.75kA combination wave for indoor locations, for applications requiring higher level of protection additional surge protection must be provided.

LEDs provide nominal 80 CRI at 3000 K, 3500 K,4000 K, or 5000 K.

Lumen output up to 2,000 lumens per foot. In 86°F (30°C) ambient environments. Luminaire should be installed in applications where ambient temperatures do not exceed 86°F (30°C).

INSTALLATION — Tool-less channel cover for easy installation.

Fixture may be surface mounted (with or without ZSPRG hanger), pendant or stem mounted with appropriate mounting options. Three-point aligner locks in place for easy continuous row mounting.

LISTINGS — CSA certified to US and Canadian safety standards. For use in damp locations between -40°F (-40°C) and 86°F (30°C).

DesignLights Consortium® (DLC) qualified product. Not all versions of this product may be DLC qualified. Please check the DLC Qualified Products List at www.designlights.org to confirm which versions are qualified.

WARRANTY — 5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/support/customer-support/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application.

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

Catalog Number	
Notes	
Type	

LED Striplight

ZL1N

24", 48" and 96" Lengths

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® or XPoint™ Wireless control networks marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

Type:
AL02c

Page 1 of 6

Lighting Notes:

1. Mounting to be coordinated with architect
2. Mounting and installation of conduit and routing path to be coordinated with architect.
3. Coordinate suspension length according to architectural drawings.
4. Provide suspension accessories: AIRCRAFT CABLE

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:
AL02c
Page 2 of 6

ZL1N LED Striplight

A+ Capable options indicated by this color background.

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Example: ZL1N L48 3000LM FST MVOLT 40K 80CRI WH

Series		Length		Reflectors[2]		Nominal lumens[3]		Diffuser		Voltage	
ZL1N	LED striplight	L24	24"[1]	(blank)	Less reflector	1500LM	1,500 lumens	FST	Snap on frosted, diffuse	MVOLT	120-277V
				SMR	Symmetric	2500LM	2,500 lumens	L/LENS	No diffuser	120	120V
						3500LM	3,500 lumens	SBL FST	Straight blade louver with snap on frosted, diffuse	208	208V
		L46	46"	(blank)	Less reflector	3000LM	3,000 lumens			240	240V
		L48	48"	ASR	Asymmetric (L48 only)	5000LM	5,000 lumens			277	277V
				SMR	Symmetric	7000LM	7,000 lumens			347	347V[4]
TZL1N	LED striplight	L92	92"	(blank)	Less reflector	6000LM	6,000 lumens			480	480V[4]
		L96	96"	SMR	Symmetric	10000LM	10,000 lumens				
						14000LM	14,000 lumens				

Color temperature		Color rendering index		Options			Paint finish	
30K	3000 K	80CRI	80 CRI	PLR___	Plug-in wiring[5,6]	**Individual Controls**[5]	WH	White
35K	3500 K	90CRI	90 CRI	PLR1LVG	Plug-in wiring-low voltage[5,6]	LBOZU 360° low mount motion sensor, pre-wired[10]	GALV	Galvanized
40K	4000 K			E7W	Emergency battery pack, 7W CA Title 20 Noncompliant[7]	LBH0SZU 360° low mount motion sensor with dimming, pre-wired[10]	MB	Matte black
50K	5000 K			2E7W	Two Emergency battery packs, 7W CA Title 20 Noncompliant[7,8]	LBPZU 360° low mount motion sensor with photocell, pre-wired[10]	SKGY	Smoke gray
				E10WLCP	Emergency battery pack, 10W Linear Constant Power, Certified in CA Title 20 MAEDBS[7]	LBM0SZU 360° low mount motion sensor, dimming & switching photocell, pre-wired[10]		
				2E10WLCP	Two Emergency battery packs, 10W Linear Constant Power, Certified in CA Title 20 MAEDBS[7,8]	**Cord sets:**[11]		
				E15WLCP	Emergency battery pack, 15W Linear Constant Power, Certified in CA Title 20 MAEDBS[7,8]	CS1W Straight plug, 120V		
				OUTEND	Cord set to exit endplate of fixture	CS3W Twist-lock, 120V		
				Wireless Controls[5]		CS7W Straight plug, 277V		
				NLTAIR2 RLSXR10	nLight Air Generation 2 Fixture mount, LSXR sensor low mount 360˚	CS11W Twist-lock, 277V		
				NLTAIR2 RLSXR10EM	nLight Air Generation 2 Fixture mount, LSXR sensor low mount 360˚, UL924 Emergency operation[9]	CS25W Twist-lock, 347V		
						CS97W Twist-lock, 480V		
						CS93W 600V SEOOW white cord, no plug (no voltage required)		

Accessories: *Order as separate catalog number.*

HC36	Hanger chain, 36"	ZLR L24 SYM WH	24" symmetric reflector, white finish
ZACVH	Aircraft cable 10' (one pair)	ZLR L46 SYM UPL WH	46" symmetric reflector with uplight, white finish
ZLANGBKT	Luma-tilt™ angle bracket for shelf or ledge mounting only	ZLR L46 SYM WH	46" symmetric reflector, white finish
SQ_	Stem kit, 2" increments up to 48"	ZLR L48 ASY WH	48" asymmetric reflector, white finish
NPP16D	nLight® switching/dimming module	ZLR L48 SYM UPL WH	48" symmetric reflector with uplight, white finish
rPP20D	nLight® Air switching/dimming module	ZLR L48 SYM WH	48" symmetric reflector, white finish
LSXR	Sensor Switch® LSXR occupancy sensor[4]	ZLR L92 SYM UPL WH	92" symmetric reflector with uplight, white finish
ZSPRG	For 15/16" T-grid only	ZLR L92 SYM WH	92" symmetric reflector, white finish
WGZ24	24" wireguard, white[12]	ZLR L96 SYM UPL WH	96" symmetric reflector with uplight, white finish
WGZ48	48" wireguard, white[12,13]	ZLR L96 SYM WH	96" symmetric reflector, white finish
ZLR L24 SYM UPL WH	24" symmetric reflector with uplight, white finish	UNIVERSAL REFL ALIGNER	Universal reflector aligners, quantity 1

Notes

1 Not available with 347V, 480V or Batteries
2 Optional. Reflectors ship separately.
3 See Operational Data on page 2 for actual lumens.
4 Utilizes step down transformer.
5 See ordering information on pages 4 and 5 and rLSXR specification sheet for more configurations. When choosing Sensor and PLR for same fixture, consult the factory.
6 Not available with cord sets.
7 MVOLT only. Not available with cord sets with plugs. Battery Spec sheet linked for more information.
8 Only available with 10,000LM and 14,000LM packages.
9 MVOLT only.
10 Available with MVOLT, 347V and 480V only. This sensor configuration is suitable for minimum ambient temperature of 14°F (-10°C). See page 6 for low temperature option providing -4°F (-20°C) minimum ambient Sensors come prewired, they must be snapped into place at time of installation.
11 Cordsets exit back of fixture unless OUTEND option is specified. Must specify voltage (not required when ordering CS93W).
12 Not compatible with reflector
13 Order 2 for tandem double length fixtures (TZL1N).

ARUP
Project Number: 271565
Phone: 1 212 896 3000

ZL1N LED Striplight

Type:
AL02c

OPERATIONAL DATA

	Nominal lumen package	Length (inches)	Delivered Lumens 3000 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 3500 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 4000 K CCT @ 77°F (25°C) ambient temperature		Delivered Lumens 5000 K CCT @ 77°F (25°C) ambient temperature		Wattage @ 120V/277V	Comparable Light Source
			80 CRI	90 CRI	80 CRI	90 CRI	80 CRI	90 CRI	80 CRI	90 CRI		
Lensed	1500LM	24	1738	1409	1777	1467	1804	1494	1871	1528	15	1-lamp 17W T8
	2500LM	24	2265	1846	2315	1900	2351	1947	2438	1991	19	1-lamp 17W T8
	3500LM	24	3586	2924	3666	3026	3723	3084	3860	3152	31	1-lamp 32W T8, 1-lamp 54W T5HO, 50W HID
	3000LM	46 or 48	3172	2586	3243	2677	3293	2728	3415	2788	25	1-lamp 32W T8, 1-lamp 54W T5HO, 50W HID
	5000LM	46 or 48	4417	3601	4515	3727	4585	3798	4754	3882	34	2-lamp 32W T8, 1-lamp 54W T5HO, 70W HID
	7000LM	46 or 48	6535	5328	6681	5515	6785	5619	7035	5744	52	3-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	6000LM	92 or 96	6561	5349	6708	5537	6812	5642	7063	5767	48	3-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	10000LM	92 or 96	8687	7082	8881	7331	9019	7470	9351	7636	68	4-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	14000LM	92 or 96	12457	10513	12735	10665	12933	10711	13409	10949	104	4-lamp 32W T8, 3-lamp 54W T5HO, 150W HID
Unlensed	1500LM	24	1881	1534	1923	1588	1953	1618	2025	1654	15	1-lamp 17W T8
	2500LM	24	2452	1999	2506	2069	2545	2108	2639	2155	19	1-lamp 17W T8
	3500LM	24	3882	3165	3969	3276	4031	3338	4179	3412	31	1-lamp 32W T8, 1-lamp 54W T5HO, 50W HID
	3000LM	46 or 48	3434	2800	3511	2898	3565	2953	3697	3019	25	1-lamp 32W T8, 1-lamp 54W T5HO, 50W HID
	5000LM	46 or 48	4781	3898	4888	4035	4964	4111	5147	4203	34	2-lamp 32W T8, 1-lamp 54W T5HO, 70W HID
	7000LM	46 or 48	7075	5768	7233	5971	7345	6083	7616	6219	52	3-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	6000LM	92 or 96	7103	5791	7261	5995	7374	6108	7646	6243	48	3-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	10000LM	92 or 96	9404	7667	9614	7937	9764	8087	10123	8266	68	4-lamp 32W T8, 2-lamp 54W T5HO, 100W HID
	14000LM	92 or 96	13485	10994	13786	11381	14001	11596	14516	11853	104	4-lamp 32W T8, 3-lamp 54W T5HO, 150W HID

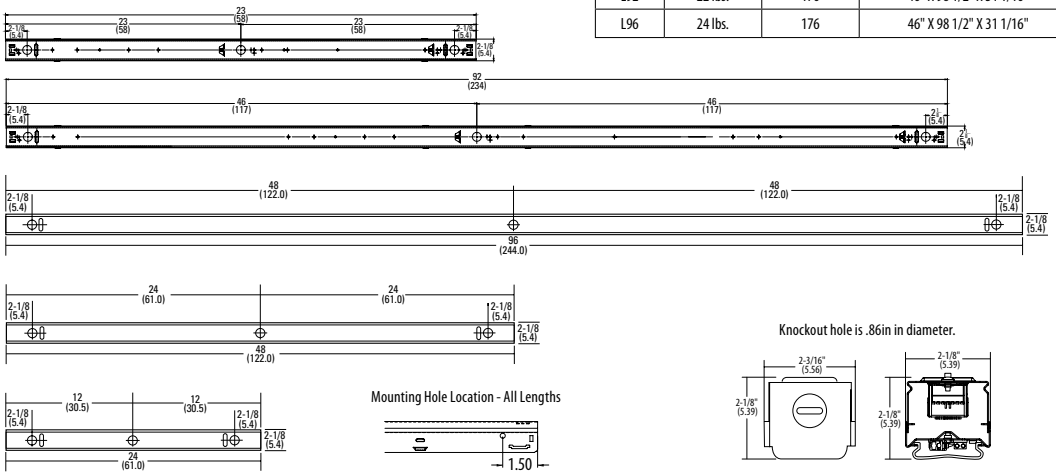
DIMENSIONS

All dimensions are shown in inches (centimeters) unless otherwise noted.

Specifications subject to change without notice.

PALLET DIMENSIONS

Length	Approximate weight	Fixtures per pallet	Approximate pallet dimensions (L x W x H)
L24	7 lbs.	408	46" X 51" X 32 11/16"
L46	11 lbs.	176	46" X 51" X 32 1/16"
L48	12 lbs.	176	46" X 51" X 31 3/8"
L92	22 lbs.	176	46" X 98 1/2" X 31 1/16"
L96	24 lbs.	176	46" X 98 1/2" X 31 1/16"



Mounting Hole Location - All Lengths

Knockout hole is .86in in diameter.

PHOTOMETRICS

Please see www.lithonia.com

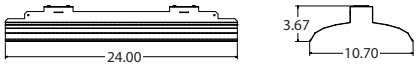
ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:
AL02c
Page 4 of 6

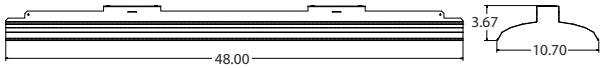
ZL1N LED Striplight

REFLECTORS (Optional)

L24 Reflector



L48 Reflector



L96 Reflector

PHOTOMETRICS

Please see www.lithonia.com

PRODUCT INFORMATION

Advanced plug-in system with two-circuit capability. Available on industrial and strip products and a variety of architectural products mounted in continuous rows. 1, 2, 3 and 4-lamp fixtures. PLR22 (2-circuit) and crossover harness switches hot circuit serving next fixture in row. Reduces fixture types on job for alternating circuit applications (see example below.)

Easy one-step installation, saves up to 35% on labor costs. Expanded switching flexibility helps save energy.

Rows can be 50% longer with two-circuit systems. Polarized, lock-together nylon connectors prevent miswiring in the field. #12 THHN conductor, rated 600V, 90°C. White neutral wire included. Grounding accomplished by fixture in-row connectors.

CSA certified systems available with up to 2 circuits. G ground required.

Note: Specifications subject to change without notice.

Wiring

PLR

Advanced 1 or 2-Circuit Plug-In

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative.

Series	Number of hot wires	Branch circuits		Dimming	Ground
PLR	(blank) Not required for 22	Circuits to which ballast is connected	Emergency circuit connected	LV Low-voltage dimming	G Ground, required
PLR22	1 Black	(blank) Not required for 22 or PLR1	(blank) No emergency circuit		
	2 Black and red	A Black wire	ELA Emergency circuit wired to black wire		
		B Red wire	ELB Emergency circuit wired to red wire		

Typical Applications

- Multiple-circuit and single-circuit for longer continuous rows
- Multiple-circuit with alternating fixtures on separate circuits, 2-circuit (PLR 22)
- Multiple circuit with night-lights located along row as desired

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:
AL02c
Page 5 of 6

ZL1N LED Striplight

LSXR – Fixture Mount Occupancy Sensor (see www.AcuityControls.com for additional information)

- Three interchangeable lens options to satisfy multiple mounting heights and coverage pattern requirements.
- Integrated mounting bracket drops lens down 3" from chase nipple.
- Single or dual relay versions — designed with robust protection from the harsh switching requirements of T5 and LED loads.
- Photocell and 0-10VDC dimming options.
- No PIR field calibration or sensitivity adjustments required.
- Sensor ambient temperature rating of 14°F (-10°C) to 131°F (55°C).

LSXR configuration	Comparable CMRB sensor	Old style sensor nomenclature
For shortest lead times use one of the following LSXR configurations		
LCOZU	CMRB 50	MSI
LCH0SZU	CMRB 50 D	MSID
LCPZU	CMRB 50 P	MSIPED
LAOZU	CMRB 6	MSI360
LAH0SZU	CMRB 6 D	MSI360D
LAPZU	CMRB 6 P	MSI360PED

SELECTIONS BELOW WILL EXTEND ORDER LEAD TIME. CONSULT YOUR SALES REPRESENTATIVE FOR DETAILS.

SINGLE RELAY

ORDERING INFORMATION — **Example**: LAH0SZU

Series	Lens option	Dimming/Photocell	Max. dim level	Min. dim level	Temp/Humidity	Default occupancy time delay
L LSXR passive infrared indoor occupancy sensor	A High mount, 360° B Low mount, 360° C High mount aisleway	0 None[1] H High/low occupancy operation P Switching photocell (on/off)[1] M Dimming and switching photocell G Dimming and switching photocell with high/low occupancy operation	0 10 VDC 9 9 VDC 8 8 VDC 7 7 VDC	S Minimum dim level of ballast 1 1 VDC 2 2 VDC 3 3 VDC 4 4 VDC 5 5 VDC 6 6 VDC	Z None T Low temperature[2]	I 30 sec D 2.5 min X 5.0 min R 7.5 min U 10.0 min (with minimum 15 minute on time) V 15.0 min W 20.0 min Y 30.0 min

Notes
1 Max and min dim levels not applicable with this option.
2 Ambient temperature rating of -4°F (-20°C) to 131°F (55°C).

DUAL RELAY (Available with 120, 277, and 347V only)

ORDERING INFORMATION — **Example**: LA2KZU

Series	Lens option	Poles	Operating mode	Temp/Humidity	Default occupancy time delay
L LSXR passive infrared indoor occupancy sensor	A High mount, 360° B Low mount, 360° C High mount aisleway	2 Dual relay	J None K Alternating off relays (promotes even lamp wear) O Alternating off relays w/photocell P Switching photocell(on/off) E Photocell on/off (pole 1 only) F Photocell on/off - both poles (dual set-point)	Z None T Low temperature[1]	I 30 sec D 2.5 min X 5.0 min R 7.5 min U 10.0 min (with minimum 15 minute on time) V 15.0 min W 20.0 min Y 30.0 min

Notes
1 Ambient temperature rating of -4°F (-20°C) to 131°F (55°C).

Example: LENS 50 J100

Replacement lenses: *Order as separate catalog number.*

Series	Lens type	Package quantity
LENS	6 High mount 360° 10 Low mount 360° 50 High mount aisleway	[blank] Single Lens J10 10-pack J100 100-pack

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Type:
AL02c
Page 6 of 6

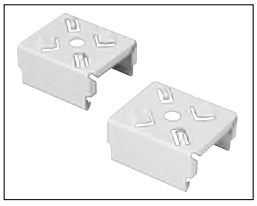
ZL1N LED Striplight

OPTIONS AND ACCESSORIES

The Z Series fixture offers numerous options for almost every electrical and optical component, including a long list of field-installable accessories.

HANGER CHAIN
36" chain with Y hanger.

Order as:
HC36



Z SPRING HANGER
Snap 'n' lock design requires no fasteners and can be used on T-grid ceiling or universal mounting systems.

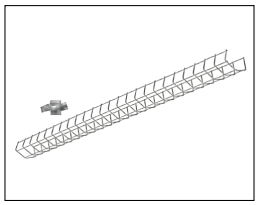
Order as:
ZSPRG

ZACVH HANGER
10' Aircraft cable with Y hanger.

Order as:
ZACVH

ANGLE MOUNTING BRACKET
Luma-tilt™ angle bracket ships as a pair

Order as:
ZLANGBKT



WIRE GUARD

Order as:
WGZ24
WGZ48

© 2013-2020 Acuity Brands Lighting, Inc. All rights reserved.

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Manufacturer: CORONET : LSR2 LED LTG1
Description: Recessed Linear

Fixture Wattage: 40 W
Lumen Output: 3656 lumen
Lamp CRI: 90+
Lighting Controls: 0-10V Dimming

Voltage: 120 V
Fixture Finish: Anodized Aluminum
Lamp CCT: 4000K
Assembly Code: LSR2 LED 4 40 LTG3 UNV DB1% CC F SD

Type: AL16

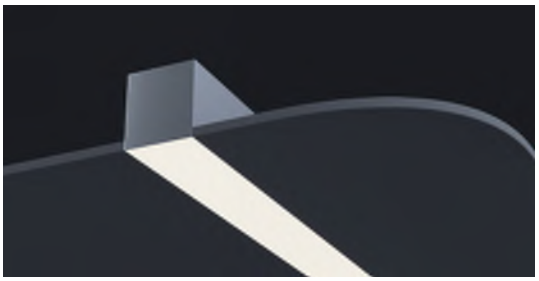
Lighting Notes:

1. Contractor to verify mounting type compatibility with ceiling type.

Coronet

LSR2 LED

DATE	PROJECT	FIRM	TYPE



Narrow, recessed, architectural luminaire with semi-recessed lens (protrudes 3/8" from ceiling). For use in indoor applications where an LED luminaire with small profile providing continuous light is required. Suitable for grid systems or drywall installation as well as custom mounting requests.

FEATURES

- Available In Made To Measure Lengths Accurate Up To 1/16"
- Patterns Available (See Page 3)
- Damp Location Rated
- CRI 90+ Standard; R9>50
- 5 Year, 50,000 Hour Fixture Warranty
- 2700K, 3000K, 3500K, 4000K & 5000K Color Temperatures Available
- Available with PoE

APPLICATIONS Offices, Lobbies, Retail Stores, Classrooms, Reception Areas & Corridors

CONSTRUCTION Extruded Aluminum Housing with Steel End Caps. Formed Steel Gear Tray

OPTICS Extruded High Transmission Satin Acrylic Lens with No LED Imaging. Flat Lens Optional

WARRANTY 5 Year Limited Warranty (Covers Standard Components)

FINISH Standard Powder-Coated White. Custom RAL Colors Available

FIXTURE RATINGS & CERTIFICATIONS Union Made, Made In The USA, ETL Listed, Damp Location Rated

*Must Specify JA8 Compliant Driver

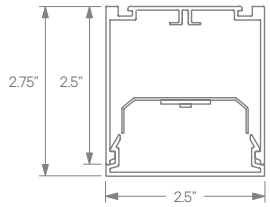
ELECTRICAL Integral Driver with 0-10V Dimming Standard. Several Driver Options Available

DRIVERS & SENSORS

For Wiring Diagrams and Sensor Information Click Here

EXTRUSION DIMENSIONS

NOTE: STANDARD LENS SITS 1/4" BELOW EXTRUDED HOUSING. FLUSH LENS OPTION AVAILABLE.



LED SYSTEM INFORMATION

	Nominal System Watts	Nominal Delivered Lumens	Nominal Efficacy
Standard (LTG1)	7.25 W/ft	675 lm/ft	94 LPW
Low (LTG2)	5 W/ft	508 lm/ft	95 LPW
High (LTG3)	10 W/ft	914 lm/ft	92 LPW

Based on a 3500K luminaire using one driver. Custom outputs available; specify below.

ORDERING

1	2	3	4	5	6	7	8	9	10	11	12

1 - FIXTURE ID
LSR2 LED

2 - LENGTH
2 - 2 ft
4 - 4 ft
8 - 8 ft
X'-X" - Specify Length
PAT - Pattern (Consult Factory)

3 - COLOR TEMP
27 - 2700K/90 CRI
30 - 3000K/90 CRI
35 - 3500K/90 CRI
40 - 4000K/90 CRI
50 - 5000K/90 CRI
TW* - Tunable White
RGBW** - RGB+3000K
*Must use DMX or TW10 Driver
**Must use DMX Driver

4 - LED SYSTEM
LTG1 - Standard
LTG2 - Low
LTG3 - High
LTGC - Custom Output

5 - VOLTAGE
UNV - Universal (120/277V)

6 - DRIVER
DB - Standard Dimming (0-10V)
DB1% - 1% Dimming (0-10V)
DB.1% - 0.1% Dimming (0-10V)
LTEA - Lutron 2-wire 1% Dimming (120V only)
LDE1 - Lutron Digital EcoSystem
LDE5 - 5 Series EcoSystem; 5% Dimming
JA8 - JA8 Compliant 1% Dimming (0-10V)
PoE - Power over Ethernet. Consult Factory for Compatibility
DMX - For Color Tuning and RGBW (Remote)
TW10 - Dual Channel, 0-10V For Color Tuning (CCT and Intensity Control)

7 - FINISH
W - White (Standard)
CC - Custom Color (provide RAL#)

8 - MOUNTING
T - 9/16" Tee Grid
T15 - 15/16" Tee Grid
SG - Slot Grid/Interlude
F - Flange
NT - No Trim/Spackle Flange
PM-X* - Perimeter Mount
*"X" denotes mounting type on opposite side of wall (ie-**PM-NT**). Consult Factory

9 - OPTICS
SD - Standard Diffuser
FL - Flat Lens

10 - CONTROL (Optional)
EIS - Enlighted Sensor
WISD - Wattstopper Daylight Sensor
WISM - Wattstopper Occupancy Sensor
SLS - SensiLUM Sensor
ACS - Acuity Controls nLight System
CCS - Casambi Compatible
ECS - Eaton WaveLinx System
*For other control systems not listed consult factory.

11 - CIRCUIT (Optional)
EM 120V - Emergency Pack
EM 277V - Emergency Pack

11 - OTHER OPTIONS
WH6 - 6ft Whips Preinstalled
CP - Chicago Plenum

Updated: 07/21/2020

CORONET, Inc.
55 Shepherds Lane
Totowa, NJ 07512

T 973 345 7660
F 973 345 8705

CORONET, Inc. reserves the right to make any design changes for continuous improvement which will not affect the overall appearance or performance.

WWW.CORONETLED.COM

1/3

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Coronet

LSR2 LED

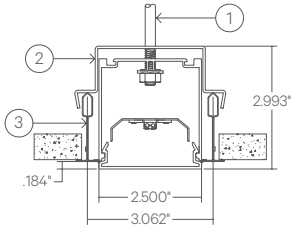
Type: AL16

Page 2 of 3

DATE	PROJECT	FIRM	TYPE

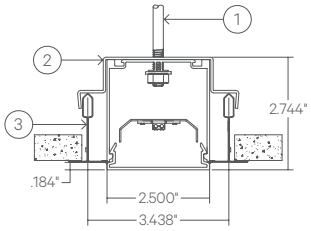
MOUNTING OPTIONS

T - 9/16" Tee Grid



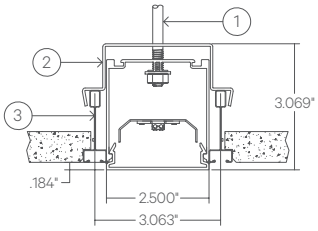
1 - Threaded Rod (not supplied)
2 - Tee Grid Bracket
3 - Tee Grid

T15 - 15/16" Tee Grid



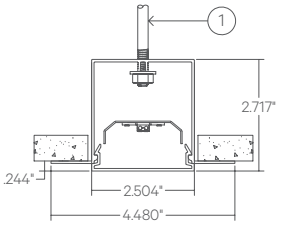
1 - Threaded Rod (not supplied)
2 - Tee Grid Bracket
3 - Tee Grid

SG - Slot Grid/Interlude



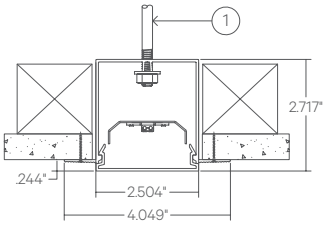
1 - Threaded Rod (not supplied)
2 - Slot Grid Bracket
3 - Slot Grid

F - Flange



1 - Threaded Rod (not supplied)

NT - No Trim/Spackle Flange



1 - Threaded Rod (not supplied)

Updated: 07/21/2020

CORONET, Inc.
55 Shepherds Lane
Totowa, NJ 07512

T 973 345 7660
F 973 345 8705

CORONET, Inc. reserves the right to make any design changes for continuous improvement which will not affect the overall appearance or performance.

WWW.CORONETLED.COM

2/3

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Coronet

LSR2 LED

Type: AL16

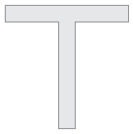
DATE	PROJECT	FIRM	TYPE

PATTERNS

Patterns feature illuminated corners and angles. **Must consult factory for custom corners and patterns.**

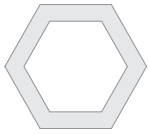
Square Patterns

X Patterns



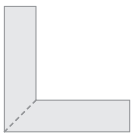
T Patterns

Custom Angles



Custom Patterns

LENS CUT



Mitered

Updated: 07/21/2020

CORONET, Inc.
55 Shepherds Lane
Totowa, NJ 07512

T 973 345 7660
F 973 345 8705

CORONET, Inc. reserves the right to make any design changes for continuous improvement which will not affect the overall appearance or performance.

WWW.CORONETLED.COM

3/3

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Manufacturer: CORONET : LSR2 LED LTG1
Description: Recessed Linear

Fixture Wattage: 80 W
Lumen Output: 7312 lumen
Lamp CRI: 90+
Lighting Controls: 0-10V Dimming

Voltage: 120 V
Fixture Finish: Anodized Aluminum
Lamp CCT: 4000K
Assembly Code: LSR2 LED 8 40 LTG3 UNV DB1% CC F SD

Type: AL15

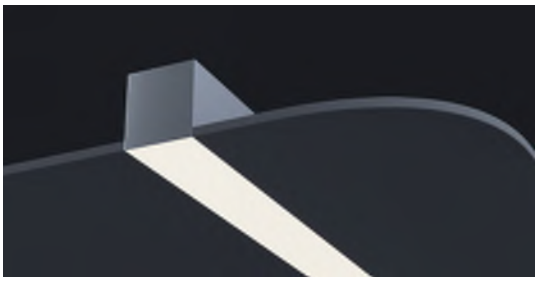
Lighting Notes:

1. Contractor to verify mounting type compatibility with ceiling type.

Coronet

LSR2 LED

DATE	PROJECT	FIRM	TYPE



Narrow, recessed, architectural luminaire with semi-recessed lens (protrudes 3/8" from ceiling). For use in indoor applications where an LED luminaire with small profile providing continuous light is required. Suitable for grid systems or drywall installation as well as custom mounting requests.

FEATURES

- Available In Made To Measure Lengths Accurate Up To 1/16"
- Patterns Available (See Page 3)
- Damp Location Rated
- CRI 90+ Standard; R9>50
- 5 Year, 50,000 Hour Fixture Warranty
- 2700K, 3000K, 3500K, 4000K & 5000K Color Temperatures Available
- Available with PoE

APPLICATIONS Offices, Lobbies, Retail Stores, Classrooms, Reception Areas & Corridors

CONSTRUCTION Extruded Aluminum Housing with Steel End Caps. Formed Steel Gear Tray

OPTICS Extruded High Transmission Satin Acrylic Lens with No LED Imaging. Flat Lens Optional

WARRANTY 5 Year Limited Warranty (Covers Standard Components)

FINISH Standard Powder-Coated White. Custom RAL Colors Available

FIXTURE RATINGS & CERTIFICATIONS Union Made, Made In The USA, ETL Listed, Damp Location Rated

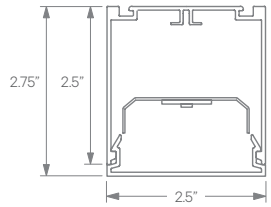
*Must Specify JA8 Compliant Driver

ELECTRICAL Integral Driver with 0-10V Dimming Standard. Several Driver Options Available

DRIVERS & SENSORS

For Wiring Diagrams and Sensor Information Click Here

EXTRUSION DIMENSIONS



NOTE: STANDARD LENS SITS 1/4" BELOW EXTRUDED HOUSING. FLUSH LENS OPTION AVAILABLE.

LED SYSTEM INFORMATION

	Nominal System Watts	Nominal Delivered Lumens	Nominal Efficacy
Standard (LTG1)	7.25 W/ft	675 lm/ft	94 LPW
Low (LTG2)	5 W/ft	508 lm/ft	95 LPW
High (LTG3)	10 W/ft	914 lm/ft	92 LPW

Based on a 3500K luminaire using one driver. Custom outputs available; specify below.

ORDERING

1	2	3	4	5	6	7	8	9	10	11	12

1 - FIXTURE ID
LSR2 LED

2 - LENGTH
2 - 2 ft
4 - 4 ft
8 - 8 ft
X'-X" - Specify Length
PAT - Pattern (Consult Factory)

3 - COLOR TEMP
27 - 2700K/90 CRI
30 - 3000K/90 CRI
35 - 3500K/90 CRI
40 - 4000K/90 CRI
50 - 5000K/90 CRI
TW* - Tunable White
RGBW** - RGB+3000K
*Must use DMX or TW10 Driver
**Must use DMX Driver

4 - LED SYSTEM
LTG1 - Standard
LTG2 - Low
LTG3 - High
LTGC - Custom Output

5 - VOLTAGE
UNV - Universal (120/277V)

6 - DRIVER
DB - Standard Dimming (0-10V)
DB1% - 1% Dimming (0-10V)
DB.1% - 0.1% Dimming (0-10V)
LTEA - Lutron 2-wire 1% Dimming (120V only)
LDE1 - Lutron Digital EcoSystem
LDE5 - 5 Series EcoSystem; 5% Dimming
JA8 - JA8 Compliant 1% Dimming (0-10V)
PoE - Power over Ethernet. Consult Factory for Compatibility
DMX - For Color Tuning and RGBW (Remote)
TW10 - Dual Channel, 0-10V For Color Tuning (CCT and Intensity Control)

7 - FINISH
W - White (Standard)
CC - Custom Color (provide RAL#)

8 - MOUNTING
T - 9/16" Tee Grid
T15 - 15/16" Tee Grid
SG - Slot Grid/Interlude
F - Flange
NT - No Trim/Spackle Flange
PM-X* - Perimeter Mount
*"X" denotes mounting type on opposite side of wall (ie-**PM-NT**). Consult Factory

9 - OPTICS
SD - Standard Diffuser
FL - Flat Lens

10 - CONTROL (Optional)
EIS - Enlighted Sensor
WISD - Wattstopper Daylight Sensor
WISM - Wattstopper Occupancy Sensor
SLS - SensiLUM Sensor
ACS - Acuity Controls nLight System
CCS - Casambi Compatible
ECS - Eaton WaveLinx System
*For other control systems not listed consult factory.

11 - CIRCUIT (Optional)
EM 120V - Emergency Pack
EM 277V - Emergency Pack

11 - OTHER OPTIONS
WH6 - 6ft Whips Preinstalled
CP - Chicago Plenum

Updated: 07/21/2020

CORONET, Inc.
55 Shepherds Lane
Totowa, NJ 07512

T 973 345 7660
F 973 345 8705

CORONET, Inc. reserves the right to make any design changes for continuous improvement which will not affect the overall appearance or performance.

WWW.CORONETLED.COM

1/3

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Coronet

LSR2 LED

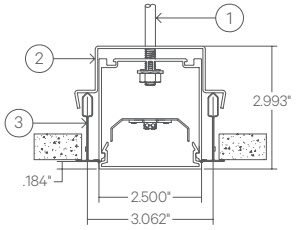
Type: AL15

Page 2 of 3

DATE	PROJECT	FIRM	TYPE

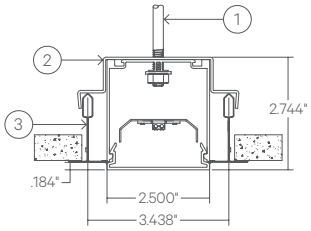
MOUNTING OPTIONS

T - 9/16" Tee Grid



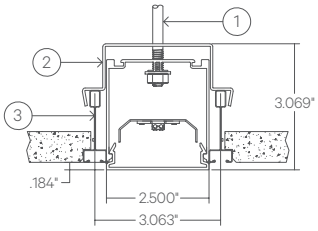
1 - Threaded Rod (not supplied)
2 - Tee Grid Bracket
3 - Tee Grid

T15 - 15/16" Tee Grid



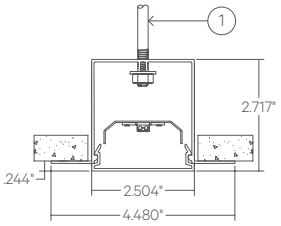
1 - Threaded Rod (not supplied)
2 - Tee Grid Bracket
3 - Tee Grid

SG - Slot Grid/Interlude



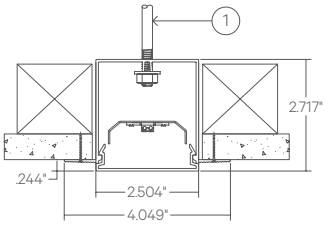
1 - Threaded Rod (not supplied)
2 - Slot Grid Bracket
3 - Slot Grid

F - Flange



1 - Threaded Rod (not supplied)

NT - No Trim/Spackle Flange



1 - Threaded Rod (not supplied)

Updated: 07/21/2020

CORONET, Inc.
55 Shepherds Lane
Totowa, NJ 07512

T 973 345 7660
F 973 345 8705

CORONET, Inc. reserves the right to make any design changes for continuous improvement which will not affect the overall appearance or performance.

WWW.CORONETLED.COM

2/3

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Coronet

LSR2 LED

Type: AL15

Page 3 of 3

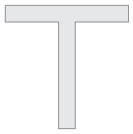
DATE	PROJECT	FIRM	TYPE

PATTERNS

Patterns feature illuminated corners and angles. **Must consult factory for custom corners and patterns.**

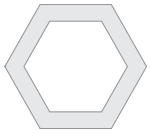
Square Patterns

X Patterns



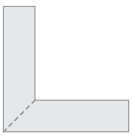
T Patterns

Custom Angles



Custom Patterns

LENS CUT



Mitered

Updated: 07/21/2020

CORONET, Inc.
55 Shepherds Lane
Totowa, NJ 07512

T 973 345 7660
F 973 345 8705

CORONET, Inc. reserves the right to make any design changes for continuous improvement which will not affect the overall appearance or performance.

WWW.CORONETLED.COM

3/3

ARUP
Project Number: 271565
Phone: 1 212 896 3000

Remove page Remove page

Storm King Lighting Controls Narrative

Space Type	LPD	Target Illuminance (fc)	Lighting Control Intent									Narrative	CCT	CRI
			Local Control	Restricted to manual ON	Restricted to partial automatic ON	Bilevel lighting control	Automatic Daylight Responsive Controls for sidelighting	Automatic Daylight Responsive Controls for toplighting	Automatic Partial Off	Automatic Full Off	Scheduled Shutoff			
External Ligthing														
Space														
Pavilion	0.1 W/ft2	1 - 5	External Lighting shall be programmed to operate automatically under timeclock control at a centralized location, with access and permissions to be agreed with the client. Timing and programming sequences shall be determined together with the Client and Building Facilities Manager. The astronomical timeclock shall operate so that lighting switches ON during Storm King operating hours 15 minutes before sunset, and shall be programmed to switch OFF or dim to 50% a a curfew time of 8.30pm or such time as is determined appropriate by the Occupant.										3000K	80+
Building Entries	30 W/ft (main entry) 20 W/ft (secondary)	0.5 - 1											3000K	80+
Parking	0.1 W/ft2	0.1 - 0.5 (ADA)											3000K	80+
Walkways (≥10ft wide / plaza)	0.16 W/sq.ft	0.1 - 0.5											3000K	80+
Walkways (< 10ft wide)	0.8 W/ft	0.1 - 1											3000K	80+
Welcome Pavilion														
Space														
Ground Floor Ticketing	1.1 W/ft2	15 (general) 30-50 (reading/writing tasks)	Y	Y	N	Y	Y	Y	N	Y	N	Local room controller with communication to control devices – a smart switch for dimming fixtures via 0-10v relay and motion sensors. Motion sensors shall be provided throughout the space for absence detection, to switch OFF luminaires when no movement is detected for a period of 30 minutes.	3000K	80+
Nursing Room	0.87 W/ft2	20	Y	N	N	Y	Y	Y	N	Y	N	Lighting shall be controlled from on-switch motion sensors integrated to local lighting switch. There shall be a motion detector to signal lights off 30 minutes after the last signal is detected. A room switch shall be provided for manual override – a smart switch for dimming fixtures via 0-10v relay and motion sensors.	3000K	80+
Bathrooms	0.98 W/ft2	5 (general) 15 (fixtures)	N	N	N	N	Y	Y	N	Y	N	Lighting shall be controlled from on-switch motion sensors integrated to local lighting switch. There shall be a motion detector to signal lights off 20 minutes after the last signal is detected. A room switch shall be provided for manual override. Cubicles will operate on motion sensors only.	3000K	90+

Space Type	LPD	Target Illuminance (fc)	Lighting Control Intent									Narrative	CCT	CRI
			Local Control	Restricted to manual ON	Restricted to partial automatic ON	Bilevel lighting control	Automatic Daylight Responsive Controls for sidelighting	Automatic Daylight Responsive Controls for toplighting	Automatic Partial Off	Automatic Full Off	Scheduled Shutoff			
Administration Building														
Space														
Food Prep	1.21 W/ft2	50	Y	Y	N	Y	Y	Y	N	Y	N	Local room controller with communication to control devices – a smart switch for dimming fixtures via 0-10v relay and motion sensors. Motion sensors shall be provided throughout the space for absence detection, to switch OFF luminaires when no movement is detected for a period of 20 minutes.	3000K	90+
Offices (Open Plan)	0.98 W/ft2	15 (general) 30-50 (reading/writing tasks)	Y	Y	N	Y	Y	Y	N	Y	N	Local room controller with communication to control devices – a smart switch for dimming fixtures via 0-10v relay and motion sensors. Motion sensors shall be provided throughout the space for absence detection, to switch OFF luminaires when no movement is detected for a period of 20 minutes.	3000K	80+
Offices (Enclosed)	1.1 W/ft2	15 (general) 30-50 (reading/writing tasks)	Y	Y	N	Y	Y	Y	N	Y	N	Local room controller with communication to control devices – a smart switch for dimming fixtures via 0-10v relay and motion sensors. Motion sensors shall be provided throughout the space for absence detection, to switch OFF luminaires when no movement is detected for a period of 20 minutes.	3000K	80+
Lobies and Vestibules	0.9 W/ft2	10 (day) 5 (night)	Y	N	N	N	Y	Y	N	Y	N	PIR motion sensors will be provided in lobbies for presence detection. Lights will turn off when the lobbies have been unoccupied for 10 minutes.	3000K	80+
Meeting/Multipurpose/Conference Rooms	1.23 W/ft2 (+ up to 1 W/sq.ft. process load)	30	Y	Y	N	Y	Y	Y	N	Y	N	Local room controller with communication to control devices – a smart switch for dimming fixtures via 0-10v relay and motion sensors. Motion sensors shall be provided throughout the space for absence detection, to switch OFF luminaires when no movement is detected for a period of 20 minutes.	3000K	90+
Library	1.71 W/ft2	20 - 30	Y	Y	N	Y	Y	Y	N	Y	N	Local room controller with communication to control devices – a smart switch for dimming fixtures via 0-10v relay and motion sensors. Motion sensors shall be provided throughout the space for absence detection, to switch OFF luminaires when no movement is detected for a period of 20 minutes.	3000K	90+
Copy Room	0.72 W/ft2	10 (general) 30 (at machines)	Y	Y	N	Y	Y	Y	N	Y	N	Local room controller with communication to control devices – a smart switch for dimming fixtures via 0-10v relay and motion sensors. Motion sensors shall be provided throughout the space for absence detection, to switch OFF luminaires when no movement is detected for a period of 20 minutes.	3000K	80+
Reception Waiting Area	0.9 W/ft2	20	Y	Y	N	Y	Y	Y	N	Y	N	Local room controller with communication to control devices – a smart switch for dimming fixtures via 0-10v relay and motion sensors. Motion sensors shall be provided throughout the space for absence detection, to switch OFF luminaires when no movement is detected for a period of 20 minutes.	3000K	80+
Reception Desk Area	0.9 W/ft2	30 - 40	Y	Y	N	Y	Y	Y	N	Y	N	Local room controller with communication to control devices – a smart switch for dimming fixtures via 0-10v relay and motion sensors. Motion sensors shall be provided throughout the space for absence detection, to switch OFF luminaires when no movement is detected for a period of 20 minutes.	3000K	80+

Space Type	LPD	Target Illuminance (fc)	Lighting Control Intent									Narrative	CCT	CRI
			Local Control	Restricted to manual ON	Restricted to partial automatic ON	Bilevel lighting control	Automatic Daylight Responsive Controls for sidelighting	Automatic Daylight Responsive Controls for toplighting	Automatic Partial Off	Automatic Full Off	Scheduled Shutoff			
Administration Building														
Stairwell	0.69 W/ft2	5 (typical use) 10 (egress stairs)	N	N	N	Y	Y	Y	Y	Y	N	Lighting shall be controlled through motion sensors located in the stair cores dimming fixtures via 0-10v relay and motion sensors. Motion sensors located in the stair cores shall be programmed to switch ON lighting to stairs and landings one floor above and below the activated sensor. Motion sensors shall also have absence detection to switch OFF luminaires when the space is unoccupied.	3000K	80+
Nursing Room	0.87 W/ft2	10	Y	N	N	Y	Y	Y	N	Y	N	Lighting shall be controlled from on-switch motion sensors integrated to local lighting switch. There shall be a motion detector to signal lights off 30 minutes after the last signal is detected. A room switch shall be provided for manual override – a smart switch for dimming fixtures via 0-10v relay and motion sensors.	3000K	80+
Break/Pantry	0.723 W/ft2	10	Y	Y	N	Y	Y	Y	N	Y	N	Local room controller with communication to control devices – a smart switch for dimming fixtures via 0-10v relay and motion sensors. Motion sensors shall be provided throughout the space for absence detection, to switch OFF luminaires when no movement is detected for a period of 20 minutes.	3000K	80+
Bathrooms	0.98 W/ft2	5 (general) 15 (fixtures)	N	N	N	N	Y	Y	N	Y	N	Lighting shall be controlled from on-switch motion sensors integrated to local lighting switch. There shall be a motion detector to signal lights off 20 minutes after the last signal is detected. A room switch shall be provided for manual override. Cubicles will operate on motion sensors only.	3000K	90+
Circulation	0.66 W/ft2	5	Y	N	N	N	Y	Y	Y	Y	N	Lighting shall be controlled through motion sensors located in the lobbies and stair cores. Motion sensors located in the stair cores shall be programmed to switch ON lighting to stairs and landings, one floor above and below the activated sensor. Motion sensors shall also have absence detection to switch OFF luminaires when the space is unoccupied.	3000K	80+
Pond Pavilion														
Space														
Café	0.65 W/ft2	10	Y	Y	N	Y	Y	Y	N	Y	N	Local room controller with communication to control devices – a smart switch for dimming fixtures via 0-10v relay and motion sensors. Motion sensors shall be provided throughout the space for absence detection, to switch OFF luminaires when no movement is detected for a period of 20 minutes.	3000K	90+
Bathrooms	0.98 W/ft2	5 (general) 15 (fixtures)	N	N	N	N	Y	Y	N	Y	N	Lighting shall be controlled from on-switch motion sensors integrated to local lighting switch. There shall be a motion detector to signal lights off 20 minutes after the last signal is detected. A room switch shall be provided for manual override. Cubicles will operate on motion sensors only.	3000K	90+
Prep	1.21 W/ft2	50	Y	Y	N	Y	Y	Y	N	Optional given safety concerns	N	Lighting shall be cntrolled by daylight sensors with manual override for safety purposes. No occupancy sensors.	3000K	90+

Space Type	LPD	Target Illuminance (fc)	Lighting Control Intent									Narrative	CCT	CRI
			Local Control	Restricted to manual ON	Restricted to partial automatic ON	Bilevel lighting control	Automatic Daylight Responsive Controls for sidelighting	Automatic Daylight Responsive Controls for toplighting	Automatic Partial Off	Automatic Full Off	Scheduled Shutoff			
Conservation & Fabrication														
Space														
Workshop	1.59 W/ft2	30 - 75	Y	Y	N	Y	Y	Y	N	Optional given safety concerns	N	Lighting shall be cntrolled by daylight sensors with manual override for safety purposes. No occupancy sensors.	4000K	90+
Offices (open plan)	0.98 W/ft2	15 (general) 30-50 (reading/writing tasks)	Y	Y	N	Y	Y	Y	N	Y	N	Local room controller with communication to control devices – a smart switch for dimming fixtures via 0-10v relay and motion sensors. Motion sensors shall be provided throughout the space for absence detection, to switch OFF luminaires when no movement is detected for a period of 20 minutes.	4000K	80+
Offices (enclosed)	1.1 W/ft2	15 (general) 30-50 (reading/writing tasks)	Y	Y	N	Y	Y	Y	N	Y	N	Local room controller with communication to control devices – a smart switch for dimming fixtures via 0-10v relay and motion sensors. Motion sensors shall be provided throughout the space for absence detection, to switch OFF luminaires when no movement is detected for a period of 20 minutes.	4000K	80+
Locker Room	0.75 W/ft2	5 - 10	Y	Y	N	Y	Y	Y	N	Y	N	Lighting shall be controlled from on-switch motion sensors integrated to local lighting switch a smart switch for dimming fixtures via 0-10v relay and motion sensors. There shall be a motion detector to signal lights off 20 minutes after the last signal is detected. A room switch shall be provided for manual override.	4000K	90+
Bathrooms	0.98 W/ft2	5 (general) 15 (fixtures)	N	N	N	N	Y	Y	N	Y	N	Lighting shall be controlled from on-switch motion sensors integrated to local lighting switch. There shall be a motion detector to signal lights off 20 minutes after the last signal is detected. A room switch shall be provided for manual override. Cubicles will operate on motion sensors only.	4000K	90+
Break/Pantry	0.72 W/ft2	10	Y	Y	N	Y	Y	Y	N	Y	N	Local room controller with communication to control devices – a smart switch for dimming fixtures via 0-10v relay and motion sensors. Motion sensors shall be provided throughout the space for absence detection, to switch OFF luminaires when no movement is detected for a period of 20 minutes.	4000K	80+

SECTION 265219 - EMERGENCY AND EXIT LIGHTING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exit signs.

1.2 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Emergency Lighting Unit: A lighting unit with integral or remote emergency battery powered supply and the means for controlling and charging the battery and unit operation.

D. Fixture: See "Luminaire" Paragraph.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 ACTION SUBMITTALS

A. Provide the following in one comprehensive submittal:

1. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support, arranged by designation.
2. Shop Drawings: For nonstandard or custom luminaires.

    a. Include plans, elevations, sections, and mounting and attachment details.
    b. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
    c. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, coordinated with each other, using input from installers of the items involved:

B. Sample Warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two year(s) from date of Substantial Completion.

B. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.2 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

A. 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.

B. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.

C. Comply with NFPA 70 and NFPA 101.

D. Comply with NEMA LE 4 for recessed luminaires.

E. Comply with UL 1598 for recessed luminaires.

2.3 EXIT SIGNS

A. Internally Lighted Signs:

1. Manufacturers: As specified in fixture schedule on drawings.
2. Operating at nominal voltage of 120 V ac.
3. Lamps for AC Operation: LEDs; 50,000 hours minimum rated lamp life.

4. 6" High lettering
5. AC only and Self-Powered Exit Signs (Battery Type): Internal emergency power unit.

2.4 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access:

1. Smooth operating, free of light leakage under operating conditions.
2. Designed to permit relamping without use of tools.
3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Housings:

1. Die-cast aluminum housing; power-coated

D. Conduit: Electrical metallic tubing, minimum 3/4 inch in diameter.

E. Battery: maintenance free NiCad battery for minimum 90-minute duration.

2.5 METAL FINISHES

A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.6 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position when testing emergency power unit.
3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of fixture weight.

E. Wall-Mounted Luminaire Support:

1. Attached using through bolts and backing plates on either side of wall.
2. Do not attach fixtures directly to gypsum board.

F. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of fixture oscillations. Support outlet box vertically to building structure using approved devices.
3. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

G. Ceiling Grid Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.

H. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.2 STARTUP SERVICE

A. Perform startup service:

1. Charge emergency power units and batteries minimum of one hour and depress switch to conduct short-duration test.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 265219

SECTION 270000 - COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. SCOPE

1. This section includes the minimum installation requirements for equipment and cabling infrastructure in Telecommunication Rooms.
2. Minimum composition requirements and installation methods for the following:

    a. Floor Mounted Racks
    b. Wall Mounted Racks and Brackets
    c. Wall Mounted Cabinets
    d. Floor Mounted Cabinets
    e. Cable Management Hardware
    f. Cable Supports/Ladder Rack
    g. Category 6A Patch Panels.
    h. Category 6A cables.
    i. Fiber Patch Panels
    j. Fiber cables
    k. Back Boards
    l. Grounding Bars
    m. Power Strips
    n. UPS Backup Power

1.2 QUALITY ASSURANCE

A. All equipment in Telecommunications Rooms shall be installed in a neat and workmanlike manner.

1. All methods of construction that are not specifically described or indicated in the Contract Documents shall be subject to the control and approval of the engineer and client. Equipment and materials shall be of the quality and manufacturer indicated. The equipment specified is based on the acceptable manufacturers listed. Where "acceptable manufacturers• is stated, equipment shall be equivalent in every way to that of the equipment specified, and subject to approval.

B. Materials and work specified herein shall comply with the requirements of:

1. TIA-568.0-D Generic Telecommunications Cabling for Customer Premesis Revision D, September 2015
2. TIA-568.1-D Commercial Building Telecommunications Infrastructure Standard
3. Revision D, September 2015
4. TIA-568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standard August 2009 - Addendum 1 June 2016
5. TIA-568.3-D Optical Fiber Cabling and Components Standard - Revision D, October 2016
6. TIA-568-C.4 Broadband Coaxial Cabling and Components Standard - Revision C, July 2011

7. TIA-569 Telecommunications Pathways and Spaces - Revision D, April 2015 - Addendum 1 October 2016
8. TIA-570 Residential Telecommunications Infrastructure Standard - Revision C, August 2012
9. TIA-598 Optical Fiber Cable Color Coding - Revision D, July 2014
10. TIA-606 Administration Standard for Telecommunications Infrastructure - Revision B, June 2012 Addendum 1, December 2015
11. TIA-607 Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premesis - Revision C, November 2015 Addendum 1, January 2017
12. TIA-758 Customer-Owned Outside Plant Telecommunications Infrastructure Standard
13. Revision B, March 2012
14. TIA-526-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant, Adoption of IEC 61280-4-2 edition 2: Fibre-Optic Communications Subsystem Test Procedures Ó Part 4-2: Installed Cable Plant Ó Single-Mode Attenuation and Optical Return Loss Measurement - Revision A, July 2015
15. TIA-526-14 Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant; Modification of IEC 61280-4-1 edition 2, Fiber-Optic Communications Subsystem Test Procedures- Part 4-1: Installed Cable Plant-Multimode Attenuation Measurement -
16. Revision C, April 2015
17. TIA-942 Telecommunications Infrastructure Standard for Data Centers - Revision A, March 2014
18. NEMA - 250
19. Federal Communications Commission 47 CFR 68.
20. BICSI Telecommunications Distribution Design Manual (current edition)
21. BICSI Customer Owned Outside Plant Design Manual (current edition)
22. BICSI Telecommunications Cabling Installation Manual (current edition)
23. ANSI/NECA/BICSI 568 Standard for Installing Commercial Building
24. Telecommunications Cabling
25. ADA - Americans with Disabilities Act
26. NFPA 70 - 2014, including:

    a. NEC - Article 770
    b. NEC - Article 800

27. Any and all applicable codes and standards at the time of contract signing

1.3 SUBMITTALS

A. Provide product data with bid for the following:

1. Floor Mounted Racks
2. Wall Mounted Racks and Brackets
3. Wall Mounted Cabinets
4. Floor Mounted Cabinets
5. Cable Management Hardware
6. Cable Supports/Ladder Rack
7. Category 6A Patch Panels.
8. Category 6A cables.
9. Fiber Patch Panels
10. Grounding Bars
11. Power Strips
12. Rack Mounted Shelves

PART 2 1.4 UNIT PRICING

2.1 Low voltage bidder shall submit line item, unit pricing for all equipment, labor, hardware, and miscellaneous system components. Further pricing breakout shall be for labor units for the installation of each item. Lump sum pricing shall NOT be accepted, and bid may be rejected as a result.

A. Unit pricing shall be valid for adds, moves, and deletes for the entire project timeline through commissioning and acceptance.

B. END OF SECTION 270000

SECTION 270526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

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:

1. Grounding conductors.
2. Grounding connectors.
3. Grounding busbars.
4. Grounding labeling.

1.3 DEFINITIONS

A. BCT: Bonding conductor for telecommunications.

B. TGB: Telecommunications grounding busbar.

C. TMGB: Telecommunications main grounding busbar.

D. Service Provider: The operator of a service that provides telecommunications transmission delivered over access provider facilities.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For communications equipment room signal reference grid. Include plans, elevations, sections, details, and attachments to other work.

1.5 INFORMATIONAL SUBMITTALS

A. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:

1. BCT, TMGB, TGBs, and routing of their bonding conductors.

B. Qualification Data: For installation supervisor, and field inspector.

C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Division 01, include the following:

a. Result of the ground-resistance test, measured at the point of BCT connection.
b. Result of the bonding-resistance test at each TGB and its nearest grounding electrode.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Installation Supervision: Installation shall be under the direct supervision of ITS Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
2. Field Inspector: Currently registered by BICSI as a RCDD designer to perform the on-site inspection.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

A. 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.

B. Comply with UL 467 for grounding and bonding materials and equipment.

C. Comply with TIA-607-C.

2.2 CONDUCTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Panduit Corp.
2. Chatsworth
3. Erico
4. Harger

B. Comply with UL 486A-486B.

C. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.

1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
2. Cable Tray Equipment Grounding Wire: No. 6 AWG.

D. Cable Tray Grounding Jumper:

1. Not smaller than No. 6 AWG and not longer than 12 inches. If jumper is a wire, it shall have a crimped grounding lug with two holes and long barrel for two crimps. If jumper is a flexible braid, it shall have a one-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.

E. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Bonding Cable: 2/0
3. Bonding Conductor: No. 6 AWG, stranded conductor.

2.3 CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide or comparable product by one of the following:

1. Chatsworth Products, Inc.
2. Panduit Corp.
3. Erico.
4. Harger

C. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

D. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.

1. Electroplated tinned copper, C and H shaped.

E. Signal Reference Grid Connectors: Combination of compression wire connectors, access floor grounding clamps, bronze U-bolt grounding clamps, and copper split-bolt connectors, designed for the purpose.

F. Busbar Connectors: Cast silicon bronze, solderless compression or exothermic-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch centers for a two-bolt connection to the busbar.

G. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING BUSBARS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Chatsworth
2. Panduit
3. Erico
4. Harger

5. Predrilling shall be with holes for use with lugs specified in this Section.
6. Mounting Hardware: Stand-off brackets that provide a 4-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
7. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

B. TGB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches 12 inches in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with TIA-607-C.

1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

C. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 6 AWG, listed as complying with UL 467, and complying with TIA-607-C. Predrilling shall be with holes for use with lugs specified in this Section.

1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
3. Rack-Mounted Vertical Busbar: 72 or 36 inches long, with stainless-steel or copper-plated hardware for attachment to the rack.

2.5 IDENTIFICATION

A. Comply with requirements for identification products in Section 270553 "Identification for Communications Systems."

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.

B. Inspect the test results of the ac grounding system measured at the point of BCT connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.

B. Comply with NECA 1.

C. Comply with TIA-607-C.

3.3 APPLICATION

A. Conductors: Install solid conductor for No. 6 AWG and larger unless otherwise indicated.

1. The bonding conductors between the TGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.

B. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Connections to Structural Steel: Welded connectors.

C. Conductor Support:

1. Secure grounding and bonding conductors at intervals of not less than 36 inches.

D. Grounding and Bonding Conductors:

1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
2. Install without splices.

3. Support at not more than 36-inch intervals.

3.4 GROUNDING ELECTRODE SYSTEM

A. The BCT between the TMGB and the ac service equipment ground shall not be smaller than No. 4/0 AWG.

3.5 GROUNDING BUSBARS

A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches minimum from wall, 12 inches above finished floor unless otherwise indicated.

B. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.6 CONNECTIONS

A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.

B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:

1. Use crimping tool and the die specific to the connector.
2. Pretwist the conductor.
3. Apply an antioxidant compound to all bolted and compression connections.

D. Primary Protector: Bond to the TMGB with insulated bonding conductor.

E. Interconnections: Interconnect all TGBs with the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot of conductor length, up to a maximum size of No. 4/0 AWG unless otherwise indicated.

F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install vertically mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB No. 2 AWG bonding conductors.

G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB and TMGB to the vertical steel of the building frame.

H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each TGB to the ground bar of the panelboard.

I. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA-568-C.1 and TIA-568-C.2 when grounding shielded balanced twisted-pair cables.

J. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

K. Access Floors: Bond all metal parts of access floors to the TGB.

L. Equipment Room Signal Reference Grid: Provide a low-impedance path between telecommunications cabinets, equipment racks, and the reference grid, using No. 6 AWG bonding conductors.

1. Install the conductors in grid pattern on 4-foot centers, allowing bonding of one pedestal from each access floor tile.
2. Bond the TGB of the equipment room to the reference grid at two or more locations.
3. Bond all conduits and piping entering the equipment room to the TGB at the perimeter of the room.

3.7 IDENTIFICATION

A. Labels shall be preprinted or computer-printed type.

1. Label TMGB(s) with "fs-TMGB," where "fs" is the telecommunications space identifier for the space containing the TMGB.
2. Label TGB(s) with "fs-TGB," where "fs" is the telecommunications space identifier for the space containing the TGB.
3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and a TGB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.

a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.

3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.

a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the TMGB and in each TGB. Maximum acceptable ac current level is 1 A.

D. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify Architect promptly and include recommendations to reduce ground resistance.

E. Grounding system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 270526

SECTION 270536 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

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:

1. Ladder cable tray.
2. Wire-mesh cable tray.
3. Trough cable tray.
4. Cable tray accessories.
5. Warning signs.

B. Related Requirements:

1. Section 260536 "Cable Trays for Electrical Systems" for cable trays and accessories serving electrical systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of cable tray.

1. Include data indicating dimensions and finishes for each type of cable tray indicated.

B. Shop Drawings: For each type of cable tray.

1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
2. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

a. Vertical and horizontal offsets and transitions.
b. Clearances for access above and to sides of cable trays.
c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
2. Vertical and horizontal offsets and transitions.
3. Clearances for access above and to side of cable trays.
4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.

B. Field quality-control reports.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cable tray supports.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 GENERAL REQUIREMENTS FOR CABLE TRAYS

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.

1. Source Limitations: Obtain cable trays and components from single manufacturer.

B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.

C. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:

1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.3 LADDER CABLE TRAY

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. B-line, an Eaton business.
2. Chalfant Manufacturing Company.
3. CPI Chatsworth

C. Description:

1. Configuration: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.
2. Width: 6 inches 18 inches unless otherwise indicated on Drawings.
3. Minimum Usable Load Depth: 4 inches.
4. Straight Section Lengths: 10 feet, except where shorter lengths are required to facilitate tray assembly.
5. Rung Spacing: 9 inches o.c.
6. Radius-Fitting Rung Spacing: 9 inches at center of tray's width.
7. Minimum Cable-Bearing Surface for Rungs: 7/8-inch width with radius edges.
8. No portion of the rungs shall protrude below the bottom plane of side rails.
9. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
10. Fitting Minimum Radius: 24 inches.
11. Class Designation: Comply with NEMA VE 1, Class 8A.
12. Splicing Assemblies: Bolted type using serrated flange locknuts.

D. Materials and Finishes:

1. Steel:

a. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1008/A 1008M, Grade 33, Type 2.
b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
d. Finish: Hot-dip galvanized after fabrication, complying with ASTM A123/A123 M, Class B2.

1) Hardware: Galvanized, ASTM B 633.

e. Finish: Hot-dip galvanized after fabrication, complying with ASTM A 653/A 653M, G90.

2.4 WIRE-MESH CABLE TRAY

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. B-line, an Eaton business.
2. Chalfant Manufacturing Company.
3. Cooper Industries; Cooper B-Line; GS Metals Corp.

C. Description:

1. Configuration: [Galvanized-] steel wire mesh, complying with NEMA VE 1.

2. Width: 6 inches 12 inches 16 inches 18 inches 24 inches unless otherwise indicated on Drawings.
3. Minimum Usable Load Depth: 4 inches.
4. Straight Section Lengths: 10 feet, except where shorter lengths are required to facilitate tray assembly.
5. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
6. Class Designation: Comply with NEMA VE 1, Class 8A .
7. Splicing Assemblies: Bolted type using serrated flange locknuts.
8. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

D. Materials and Finishes:

1. Steel:

a. Straight Sections and Fittings: Steel complies with the minimum mechanical properties of ASTM A 1008/A 1008M, Grade 33, Type 2.
b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
d. Finish: Hot-dip galvanized after fabrication, complying with ASTM A123/A123 M, Class B2.

1) Hardware: Galvanized, ASTM B 633.

e. Finish: Hot-dip galvanized after fabrication, complying with ASTM A 653/A 653M, G90.

2.5 TROUGH CABLE TRAY

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. B-line, an Eaton business.
2. Chalfant Manufacturing Company.
3. CPI Chatsworth

C. Description:

1. Configuration:

a. Single, formed sheet with a ventilated bottom, complying with NEMA VE 1.

2. Covers: Solid type made of same materials and with same finishes as cable tray.
3. Width: 6 inches 12 inches 24 inches unless otherwise indicated on Drawings.
4. Minimum Usable Load Depth: 4 inches.
5. Straight Section Lengths: 12 feet, except where shorter lengths are required to facilitate tray assembly.
6. Fitting Minimum Radius: 12 inches.

7. Class Designation: Comply with NEMA VE 1, Class 8A .
8. Splicing Assemblies: Bolted type using serrated flange locknuts.
9. Splicing Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
10. Covers: Solid type made of same materials and with same finishes as cable tray.

D. Materials and Finishes:

1. Steel:

a. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33.
b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
d. Finish: Hot-dip galvanized after fabrication complying with ASTM A123/A123 M, Class B2.

1) Hardware: Galvanized, ASTM B 633.

e. Finish: Hot-dip mill galvanized before fabrication complying with ASTM A 653/A 653M, G90.

2.6 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Barrier Strips: Same materials and finishes as for cable tray.

C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.7 WARNING SIGNS

A. Lettering: 1-1/2-inch- high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."

2.8 SOURCE QUALITY CONTROL

A. Testing: Test and inspect cable trays according to NEMA VE 1.

PART 3 EXECUTION

3.1 CABLE TRAY INSTALLATION

A. Install cable trays according to NEMA VE 2.

B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.

D. Remove burrs and sharp edges from cable trays.

E. Join aluminum cable tray with splice plates; use four square neck-carriage bolts and locknuts.

F. Fasten cable tray supports to building structure.

G. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

H. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.

I. Support bus assembly to prevent twisting from eccentric loading.

J. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.

K. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.

L. Support wire-mesh cable trays with trapeze hangers.

M. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

N. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.

O. Make changes in direction and elevation using manufacturer's recommended fittings.

P. Make cable tray connections using manufacturer's recommended fittings.

Q. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."

R. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

S. Install cable trays with enough workspace to permit access for installing cables.

T. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.

U. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.

V. Clamp covers on cable trays installed outdoors with heavy-duty clamps.

W. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."

B. Cable trays shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.

3.3 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

C. Fasten cables on vertical runs to cable trays every 18 inches.

D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.

E. Tie MI cables down every 36 inches where required to provide a 2-hour fire rating and every 72 inches elsewhere.

F. In existing construction, remove inactive or dead cables from cable trays.

3.4 CONNECTIONS

A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.

B. Connect pathways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
2. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
3. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
4. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
5. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
6. Check for improperly sized or installed bonding jumpers.
7. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
8. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 270536

SECTION 271100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

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:

1. Backboards.
2. Boxes, enclosures, and cabinets.
3. Power strips.

B. Related Requirements:

1. Section 270536 "Cable Trays for Communications Systems" for cable trays and accessories.
2. Section 271323 "Communications Optical Fiber Backbone Cabling" for optical-fiber data cabling associated with system panels and devices.
3. Section 271513 "Communications Copper Horizontal Cabling" for copper data cabling associated with system panels and devices.

1.3 DEFINITIONS

A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.

B. BICSI: Building Industry Consulting Service International.

C. RCDD: Registered communications distribution designer.

D. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.

E. TGB: Telecommunications grounding bus bar.

F. TMGB: Telecommunications main grounding bus bar.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.

2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of RCDD.
2. Installation Supervision: Installation shall be under direct supervision of Installer 2, Copper or Fiber, who shall be present at all times when Work of this Section is performed at Project site.
3. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.

PART 2 PRODUCTS

2.1 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches.

B. Backboard Paint: Light-colored interior latex paint.

2.2 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. FSR Inc.
2. Hoffman; a brand of Pentair Equipment Protection.
3. RACO; Hubbell.
4. Wiremold / Legrand.

C. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets shall be listed and labeled for intended location and use.

D. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

E. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, Type FD, ferrous alloy, with gasketed cover.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized cast iron with gasketed cover.

H. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

I. Device Box Dimensions: 4 inches square by 3-1/8 inches deep.

J. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 3R with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

K. Cabinet:

1. Equipment cabinets shall be a minimum of forty-two (42) rack units high unless otherwise stated.
2. cabinets shall be a minimum 24• wide x 36• deep, unless otherwise stated or shown in the cabinet elevation drawings.
3. Cabinet shall be provided with internal front and rear 19• racking.
4. Cabinet shall be provided with vertical cable management on both sides at the front of the cabinet.
5. Cabinet shall be provided with a lockable plexiglass front door.
6. Cabinet shall be provided with a lockable perforated rear door.
7. Cabinet shall be provided with a 6• trough fitted to both sides to allow for cable management.
8. Rated load for equipment cabinets shall be no less than 2000 pounds.
9. Cabinets are to be located as indicated on the drawings

L. Wall Mounted Open Frame Rack

1. 13U 4-Post Open Frame Rack as detailed on the drawings
2. Supports 1000 lbs (453.6 kgs) of rackmount equipment
3. Adjustable mounting depth (22 to 36 inches)
4. Textured powder coat finish
5. Heavy-duty cold-rolled steel construction
6. Numbered mounting positions
7. Manufacture “ Tripp Lite SR4POST13 or equivalent.

M. Wall Mounted Bracket

1. 4U wall-mount bracket allows vertical installation of rack-mount devices
2. Location as indicated on the drawings

3. 19-inch wall-mount rack bracket with maximum load capacity of 175 lbs.
4. Provides open, unrestricted access to equipment and cabling
5. Made from cold-rolled steel with black powder-coated finish
6. Compatible with most EIA-standard 19 in. 2-post rack equipment
7. Attaches to the Wall with User-Supplied Hardware
8. Wall-mounting holes spaced 16 in. apart for standard wall stud placement
9. Also mounts horizontally beneath a desk or workbench
10. Component hangs flush against the wall for unrestricted out-of-the-way access
11. Manufacture “ Tripp Lite SRWALLBRKT4U

2.3 POWER STRIPS

A. Comply with requirements in Section 271116 "Communications Racks, Frames, and Enclosures."

B. Power Strips: Comply with UL 1363.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Rack mounting, Height: 1 RU.

PART 3 EXECUTION

3.1 ENTRANCE FACILITIES

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.

B. Comply with requirements in Section 270528 "Pathways for Communications Systems" for materials and installation requirements for underground pathways.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI's "Telecommunications Distribution Methods Manual" for layout of communications equipment spaces.

C. Comply with BICSI's "Information Technology Systems Installation Methods Manual" for installation of equipment in communications equipment spaces.

D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

E. Coordinate layout and installation of communications equipment in tracks and in room. Coordinate service entrance configuration with service provider.

1. Meet jointly with systems providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.

3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize configurations and space requirements of communications equipment.
4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.

F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

G. Backboards:

1. Install from 6 inches to 8 feet, 6 inches above finished floor. If plywood is fire rated, ensure that fire-rating stamp is visible after installation.
2. Paint all sides of backboard with two coats of paint, leaving fire rating stamp visible.
3. Comply with requirements for backboard installation in BICSI's "Information Technology Systems Installation Methods Manual" and TIA-569-D.

3.3 SLEEVE AND SLEEVE SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.4 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI's "Information Technology Systems Installation Methods Manual," "Firestopping Practices" Ch.

END OF SECTION 271100

SECTION 271323 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

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:

1. 850 nanometer laser-optimized 50/125 micrometer multimode optical fiber cable (OM3).
2. 9/125 micrometer single-mode, indoor-outdoor optical fiber cable (OS2).
3. Optical fiber cable connecting hardware, patch panels, and cross-connects.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. RCDD: Registered Communications Distribution Designer.

1.4 OPTICAL FIBER BACKBONE CABLING DESCRIPTION

A. Optical fiber backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Reviewed and stamped by RCDD.

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.

4. Wiring diagrams to show typical wiring schematics including the following:

    a. Telecommunications rooms plans and elevations.
    b. Telecommunications pathways.
    c. Telecommunications system access points.
    d. Telecommunications grounding system.
    e. Cross-connects.
    f. Patch panels.

5. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

C. Optical fiber cable testing plan.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Product Certificates: For each type of product.

D. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For optical fiber cable, splices, and connectors to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.11 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. 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.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

C. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

D. Grounding: Comply with TIA-607-B.

2.2 850 NANOMETER LASER-OPTIMIZED, 50/125 MICROMETER, MULTIMODE OPTICAL FIBER CABLE (OM3)

A. Single -jacket, armored cable shall provide crush rodent protection, for campus backbones in direct -buried installations with water blocking capabilty. The loose tube design shall provide stable and highly reliable transmission parameters for a variety of voice, data, video and imaging applications. These cables also provide high -fiber density within a given cable diameter while allowing flexibility to suit many system configurations.

B. Description: Multimode, 50/125-micrometer, 12 -fiber, loose tube, optical fiber cable or as indicated on the drawing.

C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Belden CDT Networking Division/NORDX.
2. CommScope, Inc.
3. Corning Cable Systems.

D. Standards:

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with TIA-492AAAC for detailed specifications.

E. Maximum Attenuation: 3.0 dB/km at 850 nm; 1.5 dB/km at 1300 nm.

F. Minimum Overfilled Modal Bandwidth-length Product: 1500 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

G. Minimum Effective Modal Bandwidth-length Product: 2000 MHz-km at 850 nm.

H. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Riser Rated, Nonconductive: Type OFNP, or Type OFNR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2.3 9/125 MICROMETER, SINGLE-MODE, INDOOR-OUTDOOR OPTICAL FIBER CABLE (OS2)

A. Description: Single mode, 9/125-micrometer, 12 fibers, single loose tube, optical fiber cable or as indicated on the drawing.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Belden CDT Networking Division/NORDX.
2. Berk-Tek Leviton; a Nexans/Leviton alliance.
3. CommScope, Inc.

C. Standards:

1. Comply with TIA-568-C.3 for performance specifications.
2. Comply with ICEA S-104-696 for mechanical properties.

D. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
2. Riser Rated, Nonconductive: Type OFNP, or Type OFNR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2.4 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Belden CDT Networking Division/NORDX.
2. Berk-Tek Leviton; a Nexans/Leviton alliance.
3. Corning Cable Systems.

B. Standards:

1. Comply with Fiber Optic Connector Intermateability Standard (FOCIS) specifications of the TIA-604 series.
2. Comply with TIA-568-C.3.

C. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

D. Connector Type: Type LC complying with TIA-604-10-B, connectors.

E. Plugs and Plug Assemblies:

1. Male; color-coded modular telecommunications connector designed for termination of a single optical fiber cable.
2. Insertion loss not more than 0.75 dB.
3. Marked to indicate transmission performance.

F. Jacks and Jack Assemblies:

1. Female; quick-connect, simplex and duplex; fixed telecommunications connector designed for termination of a single optical fiber cable.
2. Insertion loss not more than 0.75 dB.
3. Marked to indicate transmission performance.
4. Designed to snap-in to a patch panel or faceplate.

2.5 GROUNDING

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Comply with TIA-607-B.

2.6 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.7 SOURCE QUALITY CONTROL

A. Factory test multimode optical fiber cables according to TIA-526-14-B and TIA-568-C.3.

B. Factory test pre-terminated optical fiber cable assemblies according to TIA-526-14-B and TIA-568-C.3.

C. Cable will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

A. Comply with NECA 1, NECA 301, and NECA/BICSI 568.

B. General Requirements for Optical Fiber Cabling Installation:

1. Comply with TIA-568-C.1 and TIA-568-C.3.
2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
3. Terminate all cables; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.

9. In the communications equipment room, provide a 10-foot- long service loop on each end of cable.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.

E. Group connecting hardware for cables into separate logical fields.

3.4 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI ITSIMM, "Firestopping" Chapter.

3.5 GROUNDING

A. Install grounding according to BICSI ITSIMM, "Grounding (Earthing), Bonding, and Electrical Protection" Chapter.

B. Comply with TIA-607-B and NECA/BICSI-607.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Visually inspect optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment, and labeling of all components.
3. Optical Fiber Cable Tests:

    a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Link End-to-End Attenuation Tests:

        1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in one direction according to TIA-526-14-B, Method B, One Reference Jumper.
        2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than those calculated according to equation in TIA-568-C.1.

C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

D. Remove and replace cabling where test results indicate that it does not comply with specified requirements.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 271323

SECTION 271513 - COMMUNICATIONS COPPER HORIZONTAL CABLING

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:

1. Category 6a twisted pair cable.
2. Twisted pair cable hardware, including plugs and jacks.
3. Multiuser telecommunications outlet assembly.
4. Cable management system.
5. Cabling identification products.
6. Grounding provisions for twisted pair cable.
7. Source quality control requirements for twisted pair cable.

1.3 DEFINITIONS

A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

B. EMI: Electromagnetic interference.

C. FTP: Shielded twisted pair.

D. F/FTP: Overall foil screened cable with foil screened twisted pair.

E. F/UTP: Overall foil screened cable with unscreened twisted pair.

F. IDC: Insulation displacement connector.

G. LAN: Local area network.

H. Jack: Also commonly called an "outlet," it is the fixed, female connector.

I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.

J. RCDD: Registered Communications Distribution Designer.

K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

L. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

M. S/FTP: Overall braid screened cable with foil screened twisted pair.

N. S/UTP: Overall braid screened cable with unscreened twisted pairs.

O. UTP: Unscreened (unshielded) twisted pair.

1.4 COPPER HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C, and the equipment outlet, otherwise known as "Cabling Subsystem 1," in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.

1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
3. Bridged taps and splices shall not be installed in the horizontal cabling.

B. A work area is approximately 100 sq. ft., and includes the components that extend from the equipment outlets to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Reviewed and stamped by RCDD.

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration Drawings and printouts.
4. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:

a. Telecommunications rooms plans and elevations.
b. Telecommunications pathways.
c. Telecommunications system access points.
d. Telecommunications grounding system.
e. Telecommunications conductor drop locations.
f. Typical telecommunications details.

C. Twisted pair cable testing plan.

D. Sustainable Design Submittals:

1. Third-Party Certifications: For each product.
2. Third-Party Certified Life Cycle Assessment: For each product.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, installation supervisor, and field inspector.

B. Product Certificates: For each type of product.

C. Source quality-control reports.

D. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For splices and connectors to include in maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On USB media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Connecting Blocks: One of each type.
2. Faceplates: One of each type.
3. Jacks: Ten of each type.
4. Patch-Panel Units: One of each type.
5. Plugs: Ten of each type.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings and cabling administration Drawings by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each pair of twisted pair cable for open and short circuits.

1.11 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.12 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-B.

2.2 GENERAL CABLE CHARACTERISTICS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:

1. Communications, Plenum Rated: Type CMP complying with UL 1685 or Type CMP in listed plenum communications raceway.

B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

C. RoHS compliant.

2.3 CATEGORY 6a TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6a cable at frequencies up to 500MHz.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Belden CDT Networking Division/NORDX.

2. Berk-Tek Leviton; a Nexans/Leviton alliance.
3. CommScope, Inc.

C. Standard: Comply with TIA-568-C.2 for Category 6a cables.

D. Conductors: 100-ohm, 23 AWG solid copper.

E. Shielding/Screening: Unshielded twisted pairs (UTP) .

F. Cable Rating: Plenum.

G. Jacket: Blue thermoplastic.

2.4 TWISTED PAIR CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Belden CDT Networking Division/NORDX.
2. Berk-Tek Leviton; a Nexans/Leviton alliance.
3. CommScope, Inc.

C. General Requirements for Twisted Pair Cable Hardware:

1. Comply with the performance requirements of Category 6a.
2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
3. Cables shall be terminated with connecting hardware of same category or higher.

D. Source Limitations: Obtain twisted pair cable hardware from single source from single manufacturer.

E. Connecting Blocks:

1. 110-style IDC for Category 6a.
2. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.

F. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

G. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.

1. Features:

a. Universal T568A and T568B wiring labels.
b. Labeling areas adjacent to conductors.
c. 24 or 48 ports.

2. Construction: 16-gauge steel and mountable on 19-inch equipment racks.
3. Number of Jacks per Field: One for each four-pair .

H. Plugs and Plug Assemblies:

1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Standard: Comply with TIA-568-C.2.
3. Marked to indicate transmission performance.

I. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Designed to snap-in to a patch panel or faceplate.
3. Standard: Comply with TIA-568-C.2.
4. Marked to indicate transmission performance.

J. Faceplate:

1. Two port, vertical single gang faceplates designed to mount to single gang wall boxes.
2. Plastic Faceplate: High-impact plastic. Coordinate color with Electrical Specifications.
3. Metal Faceplate: Stainless steelat pantries, and MEP rooms, complying with requirements in Electrial Specifications
4. For use with snap-in jacks accommodating any combination of twisted pair cables

    a. Flush mounting jacks, positioning the cord at a 45-degree angle.

K. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.5 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.6 GROUNDING

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Comply with TIA-607-B.

2.7 SOURCE QUALITY CONTROL

A. Factory test cables on reels according to TIA-568-C.1.

B. Cable will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 EXECUTION

3.1 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters. Conceal raceway and cables, except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

3.2 INSTALLATION OF PATHWAYS

A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings."

B. Comply with Section 270528 "Pathways for Communications Systems."

C. Comply with Section 270529 "Hangers and Supports for Communications Systems."

D. Comply with Section 270536 "Cable Trays for Communications Systems."

E. Drawings indicate general arrangement of pathways and fittings.

3.3 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES

A. Comply with NECA 1 and NECA/BICSI 568.

B. General Requirements for Cabling:

1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.

6. Consolidation points may be used only for making a direct connection to equipment outlets:

    a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
    b. Locate consolidation points for twisted-pair cables at least 49 feet from communications equipment room.

7. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
8. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
9. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI Information Transport Systems Installation Methods Manual , Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
10. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
11. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
12. In the communications equipment room, install a 10-foot- long service loop on each end of cable.
13. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.

b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with "Firestopping Systems" Article in BISCI's "Telecommunications Distribution Methods Manual."

3.5 GROUNDING

A. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."

B. Comply with TIA-607-B and NECA/BICSI-607.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.

D. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:

1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 271513

SECTION 272000 - DATA COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 PROJECT BACKGROUND

A. Storm King Art Center (SKAC)is a 500-acre outdoor museum located in New York¢s Hudson Valley. SKAC does not have a campus wide LAN that connects all buildings together. Instead, existing buildings have their local LAN and Wireless LAN. They get their internet services from Verizon over FIOS. A firewall sits on the network behind the incoming service. Data resources are located in the cloud and in the Museum Building. SKAC employees access these resources over virtual private networks (VPN). Telephony services at SKAC is over Fonality Inc., a cloud-based telephony provider. The telephone headend is located at the Museum Building. IP telephone handsets provided by Fonality and distributed at the various buildings are used for communications. Staff also have softphone on their computers and mobile phones.

B. The new Admin Building, the new Ticketing Building and the new Conservation Building will have FIOS connectivity. The network at the new Ticketing Building will be extended to the Restroom Building and the Canopy over fiber. Similarly, the network at the new Conservation Building will be extended to the Pond Pavilion over Fiber. The Restroom Building, the Canopy and the Pond Pavilion will have their edge switches.

C. The physical security network is a stand-alone system. The converged network described here shall supports the enterprise applications for staff, LAN for smart building applications. LAN for AV systems and wireless LAN for staff and guest.

1.2 SUMMARY

A. Work covered under this specification shall apply to all equipment and installation services provided within this specification.

B. All work shall be in accordance with Division 1 and the work performed within these specifications.

1.3 RELATED DOCUMENTS

A. 27 00 00 Communication Systems

B. 27 05 26 Grounding and Bonding for Communication Systems

C. 27 05 36 Cable Trays for Communication Systems

D. 27 11 00 Communication Equipment Room Fittings

E. 27 05 26 Communication Optical Fiber Backbone cabling

F. 27 05 26 Communications Copper Horizontal Cabling

1.4 REFERENCES

A. This section provides an overview of existing Best Practices, Standards, Guidelines and Baselines, as well as existing electrical and occupational as well as other building codes to which the finished work shall comply. Compliance with this section applies to all work to be performed by the systems integrator providing the work under the Sections made part of this bid package. Implement these practices and provide documentation that these baseline configuration policies, guidelines etc. were implemented. Follow all IETF RFCs and manufacturer¢s Solution Reference Network Design (SRND).

B. RFC 3246 An Expedited Forwarding PHB (http://www.ietf.org/rfc/rfc3246)

C. RFC 3662 A Lower Effort Per-Domain Behavior for Differentiated Services (http://www.ietf.org/rfc/rfc3662)

D. RFC 4594 Configuration Guidelines for DiffServ Service Classes (http://www.ietf.org/rfc/rfc4594)

E. ANSI/NFPA-70 Ó National Electrical Code, 2008

F. ANSI/TIA/EIA-606-A - Administration Standard for Commercial Telecommunications Infrastructure, 2002

G. ANSI/TIA-606-A-1 Ó Administration Standard for Commercial Telecommunications Infrastructure Addendum 1 Ó Administration of Equipment Rooms and Data Center Computer Rooms, 2008

H. ANSI/J-STDÓ607-A - Joint Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, 2002

I. NIST SP 800-58 Security Considerations for Voice Over IP Systems, January 2005

J. NIST SP 800-41 Guidelines on Firewalls and Firewall Policy, January 2002

K. NIST SP 800-48 Wireless Network Security: 802.11, Bluetooth, and Handheld Devices, November 2002

L. NIST SP 800-47 Security Guide for Interconnecting Information Technology Systems, August 2002

M. RFC 2474 Definition of the Differentiated Services Field (http://www.ietf.org/rfc/rfc2474)

N. RFC 2597 Assured Forwarding PHB Group (http://www.ietf.org/rfc/rfc2597)

O. NIST SP 800-31 Intrusion Detection Systems (IDS), November 2001

P. FIPS 200 Minimum Security Requirements for Federal Information and Information Systems, March 2006

Q. OSHA CFR-29, Part 1910 - Department of Labor, Code of Federal Regulations - Occupational Health and Safety Standards

R. OSHA CFR-29, Part 1926 - Department of Labor, Code of Federal Regulations - Safety and Health Regulations for Construction

1.5 SYSTEM DESCRIPTION

A. The network security appliances work shall include the installation of dedicated appliances and software to perform the required firewall and virtual private network functions

B. The network management work, network switch and router work in this section shall include the installation of dedicated appliances and software to perform the required network management functions and serve as the infrastructure for the network.

C. Wireless access point (WAP) shall support:

D. IP-based voice, video and data transmissions

1. IEEE 802.11 a, b, g, n & ac
2. WPA2-PSK and 802.1x authentication
3. Extensible Authentication Protocol Support: TLS/PEAP
4. IPv6
5. Performance requirements:
6. Signal coverage in all areas: 100%.
7. Minimum signal strength in all areas: -73dBm [@ 54 Mbps]
8. Signal strength for overlapping channels (min.): -67dBm
9. Power level: 35-50mW
10. Minimum signal to noise ratio (SNR): 25dB at 2.4 GHz

E. Required work

1. Pre-installation design review
2. Design confirmation and submittal
3. Device installation
4. Logical configuration
5. Post installation testing and refinement
6. Training

F. Work by others:

1. Racks and/or cabinets for mounting of the wireless LAN controller(s) will be coordinated with the Contractor(s) providing work under Specification Section 271100.
2. Horizontal cables from telecommunications room patch panels to outlet receptacles will be furnished, installed and tested by the Contractor(s) providing work under Specification Section 271513.
3. Backbone cabling will be furnished, installed and tested by the Contractor(s) providing work under Specification Section 271323.

1.6 SUBMITTALS

A. Product Data:

1. Each type of appliance/device
2. All other products specified in this section

B. Submittals:

1. Completed / coordinated installation plan including listing of all Owner¢s configuration requirements and settings.

C. Closeout Submittals

1. As-built plan including all configuration settings
2. Test results indicating performance of each system
3. User manuals for each product component

PART 2 PRODUCTS

2.1 NETWORK SECURITY APPLIANCE

A. Overview - high speed firewall deployment within distributed enterprise branch offices

1. 100 Mbps firewall throughput(App-ID enabled1)
2. 50 Mbps threat prevention throughput
3. 50 Mbps IPSec VPN throughput
4. 64,000 max sessions
5. 1,000 new sessions per second
6. 25 IPSec VPN tunnels/tunnel interfaces
7. 25 SSL VPN Users
8. 10 security zones
9. 250 max number of policies
10. Rack mountable with rack mountable brackets

B. Manufacture: Palo Alto, PA-200

C. Management device proposed by contractor

2.2 MANAGEMENT AGGREGATION SWITCH

A. high-bandwidth aggregation switch with connectivity to multiple switches within the network

B. Key features

1. 12 x 1G/10G SFP+ Ports
2. 4 x 1G/10G RJ-45 Ports
3. 1 x RJ-45 Serial Console Port
4. Non-Blocking Throughput: 160 Gbps
5. Forward Rate 238.1 Mpps
6. Rack mountable with rack mountable brackets

C. Manufacture: Ubiquiti Networks US-16-XG

2.3 MANAGED POE+ GIGABIT SWITCH WITH SFP - 48 port

A. Features

1. (8) Gigabit RJ45 802.3bt PoE++ ports
2. (40) Gigabit RJ45 802.3at PoE+ ports
3. (4) 10G SFP+ ports
4. Layer 2 and Layer 3 features
5. 600W maximum PoE power
6. UniFi SmartPower RPS DC input
7. Near-silent cooling
8. 1.3" touchscreen display
9. Managed by UniFi Network Controller
10. Managed by UniFi Network Controller version: 5.10.5 or higher

B. Manufacture: Ubiquiti

2.4 MANAGED POE+ GIGABIT SWITCH WITH SFP - 24 port

A. Features

1. (8) Gigabit RJ45 802.3bt PoE++ ports
2. (16) Gigabit RJ45 802.3at PoE+ ports
3. (2) 10G SFP+ ports
4. Layer 2 and Layer 3 features
5. 400W maximum PoE power
6. UniFi SmartPower RPS DC input
7. Near-silent cooling
8. 1.3" touchscreen display
9. Managed by UniFi Network Controller
10. Managed by UniFi Network Controller version: 5.10.5 or higher

B. Manufacture: Ubiquiti

2.5 MANAGED POE+ GIGABIT SWITCH WITH SFP - 8 port

A. Features

1. (8) Gigabit RJ45 Ethernet Ports
2. (2) 1G SFP Fiber Ports
3. Auto-Sensing IEEE 802.3af/at PoE
4. Configurable 24V Passive PoE
5. 10 Gbps Total, Non-Blocking Line Rate
6. Managed by UniFi Controller

B. Manufacture: Ubiquiti

2.6 Wireless Access Point - Ceiling & wall

A. compact 4x4 MU-MIMO 802.11ac Wave 2 dual-band access point with an aggregate radio rate of over 2 Gbps and supports over 200 concurrent users. Engineered to take advantage of 802.11ac Wave 2, provides powerful multi-user support in an elegant, nano-sized design.

B. Features

1. Four-Stream 802.11ac Wave 2 Technology
2. Simultaneous Dual-Band Radios
3. Supports 200+ Concurrent Users
4. 5 GHz Band 4x4 Multi-User MIMO with Radio Rate of 1.733 Gbps
5. 2.4 GHz Band 2x2 MIMO with Radio Rate of 300 Mbps
6. Powered by Gigabit 802.3af PoE+
7. Can be wall mounted or ceiling mounted
8. Option of multiple skins - coordinate finish with architect

C. Manufacture: Ubiquiti

2.7 POWER SURGE PROTECTOR AND BATTERY BACKUP

A. Features: Type 1

1. Total Outlets Ó 4
2. Protected Outlets - 4 x NEMA 5-15R (Battery and Surge)
3. Plug Type - NEMA 5-15P
4. SmartSlot Interface Ó 1
5. Communications - Serial via DE-9/DB-9 USB via Type-B
6. Maximum Wattage - 640 W
7. Nominal Input Voltage Ó 120 VAC
8. Nominal Ouput Voltage Ó 120 VAC
9. Full-load Runtime Ó 5.5 mins
10. Half Load Runtime Ó 13.4 mins
11. Dimension - 17 x 2 x 26"
12. Manufacturer Ó APC SUA1000RM1U

B. Features: Type 2

1. Total Outlets Ó 10
2. Protected Outlets - 6 x NEMA 5-15R, 3 x NEMA 5-20R, 1 x NEMA 5-30R (Battery and Surge)
3. Plug Type - NEMA 5-15P
4. SmartSlot Interface Ó 1
5. Communications - Ethernet 10/100 Mbps, RS-232, USB
6. Maximum Wattage - 3000 VA
7. Nominal Input Voltage Ó 120 VAC
8. Nominal Ouput Voltage Ó 120 VAC
9. Full-load Runtime Ó 6 mins
10. Half Load Runtime Ó 18 mins
11. Dimension - 17 x 8 x 26"
12. Manufacturer Ó APC- SMX3000LVNC

PART 3 EXECUTION

3.1 PRE-INSTALLATION DESIGN REVIEW

A. Review all design documents to ensure that the system will work according to the design intent. Note any perceived deficiencies and offer value engineering suggestions

B. Review the network design to ensure that all requirements of the system are met and issue a document either acknowledging acceptance of the network design or indicating requirements to be met such as:

1. Requirements for connectivity to the wiring infrastructure (including number and location of cables or connectivity required).
2. Allocation of IP addresses / VLAN requirements
3. Routing requirements
4. Access control lists

3.2 PREPARATION

A. Meet with the Owner representative and the General Contractor to coordinate and document the requirements for Naming conventions

1. Configuration settings
2. IP addressing, sub-netting, super-netting, DHCP and static IP allocations
3. VLAN settings
4. Individual port assignments and patching

B. Work closely with the Owner¢s IT Design Consultant to understand the detailed Layer2 and Layer 3 design. The converged LAN traffic must remain as secure as possible. Quantity of discrete VLANs could approach 20 or more. Each VLAN profile shall contain, at minimum:

1. Traffic and protocol ACLs or filters
2. QoS marking and prioritization
3. Selective deactivation of Layer 2 protocols on untrusted network segments
4. Configuration of in-band management port(s) only in dedicated VLAN(s)
5. Abstention from using VLAN 1 to carry any data traffic

C. Develop a detailed Layer 3 routing design to limit access to and from various VLANs and provide inter-networking where appropriate.

D. Provide best practice installation, including QoS recommendations based upon RFC 2597, RFC 3662, RFC 2474 and RFC 3246.

E. Coordinate the configuration of core and access layer switch terminations in order to perform end-to-end testing of the networks.

F. Anticipated protocols to be utilized in the design of the network layer 2 and Layer 3 topology include but are not limited to:

1. Open Shortest Path First
2. VLAN ACLs on all VLANs
3. DHCP Snooping
4. IP source guard
5. TACACS+ and RADIUS authentication coordination
6. MAC address notification
7. Equal-cost routing for load balancing and redundancy
8. IGMP filtering
9. Protocol Independent Multicast (PIM), including PIM sparse mode (PIM-SM), PIM dense mode (PIM-DM), and PIM sparse-dense mode
10. Distance Vector Multicast Routing Protocol (DVMRP)

G. Submit plans for review indicating the intended configuration and settings for each device.

H. Prepare and submit a testing plan inclusive of all tests to be performed in order to demonstrate the complete operation of each system and correct configuration.

I. Incorporate comments from the Using Agency and General Contractor.

J. Issue a final coordinated plan.

3.3 INSTALLATION

A. Administration Physical installation:

1. Switches and system appliances shall be located in the designated IDF/Equipment areas as indicated on the drawings. Provided distribution switch with dual 10 Gb uplinks as indicated.
2. Mount the device(s) in the designated cabinet(s) or rack(s).
3. The device(s) shall be connected across the switched / routed infrastructure to minimize a single point of failure.
4. Develop cross-connect/patching schedules for the connection of station, backbone and tie cabling as required to activate all devices and gateways to be installed.
5. Perform all horizontal copper patching work.
6. Furnish and install all fiber patch cords.

3.4 CONFIGURATION

A. Install all required software for the devices, including firmware updates. Ensure that at the time of turnover, all software and all device firmware is updated to the latest revision.

B. Program all devices according to the coordinated and approved design.

C. POST-INSTALLATION TESTING

3.5 TRAINING

A. The training programs must also be designed to meet the requirements of the system administrators, operators and end users in the use, management and maintenance of all equipment and software provided within the IT Contract. This includes, but is not limited to:

1. Core and Access switches
2. Configuration
3. Protocols
4. 802.11 Wireless Access Points (WAPs)
5. Switching
6. Gateways
7. Analog interface

B. Develop a complete training schedule including all the items provided under this contract. Provide a schedule to the Owner Representative for approval prior to the commencement of training.

C. System Administrator training:

1. Prior to the start of any training, the Contractor shall provide copies of all operations manuals, maintenance manuals, quick reference cards and any custom guides to the systems administrator(s).
2. The training program must be designed to meet the requirements of preparing system administrators for the use, programming, maintenance and troubleshooting of the systems.
3. The Contractor shall provide "over-the-shoulder' training during the configuration of the various. This informal Ütraining¢ shall also provide the Using Agency with configuration parameter updates during the build out of the components.
4. Train the Using Agency¢s technicians on the configuration and proper operation of the system.
5. Include (20) hours of dedicated training time. ÓOver the shoulder• explanations to the Owner¢s technicians while installing or configuring the system do not count toward this dedicated training time.
6. System administrator training must include but be not limited to the following topics:

D. The operation and configuration of each device

E. The features and settings of all associated software System start up, shutdown and reboot

F. Identifying system failures

G. Typical troubleshooting and common solutions

H. User sign-on and access procedures

I. Usage reports

3.6 PROTECTION

A. Keep all items protected before and after installation with dust and waterproof barrier materials as necessary. Ensure the integrity of the protective measures throughout the life of the project.

B. Protect all telecommunications network equipment from damage, at all times during the construction. In the event of direction by the Owner representative to install work in unfinished areas, take all reasonable precautions to protect the work, and notify the Owner representative, in writing, of the potential for damage and the protective steps recommended during construction completion. Take special precautions, such as powering down all equipment and temporarily wrapping (and later unwrapping) the equipment in plastic, as directed by the Owner representative.

END OF SECTION 272000

SECTION 274116

INTEGRATED AUDIOVISUAL SYSTEMS & EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Provide complete systems in compliance with drawings, general provisions of contract, including General and Supplementary Conditions, Division 1 Specifications, and Instructions to Bidders.

B. System refers to the complete and functional assemblage of equipment required to achieve the specified functionality, performance, and design intent. This shall include, but not be limited to, ancillary items such as power supplies, interfaces, transformers, cable, and connectors.

C. Scope of Work: This specification section defines certain audio and audiovisual systems to be installed in Sheltering Arms Manhattan at 25 Broadway.

D. Section Includes:

1. Supply and install a turnkey audio and audiovisual system, to include equipment and materials, whether specifically mentioned herein or not, to ensure a complete and operating system.

2. Generate submittal information for the complete fabrication, installation and wiring of the system. Provide (or sub-contract for) the on-site installation and wiring, and provide on-going supervision and coordination during implementation.

3. Provide for the initial adjustment of the systems as herein prescribed and provide test equipment for the system checkout and acceptance tests. Prior to the systems acceptance tests, submit an initial testing and tuning report showing methods and results for tests performed.

4. Provide on-the-job training in the operation and maintenance of the systems for personnel designated by the Owner.

5. Provide one-year warranty from date of system acceptance for systems installed.

E. Related Requirements: Comply with the following:

1. Section 012300 – Alternates

2. Section 013300 – Submittals

3. Section 016000 – Product Requirements

4. Section 017300 – Executive Requirements

5. Section 017329 – Cutting and Patching

6. Section 017700 – Closeout Procedures

7. Section 078413 – Firestops and Smokeseals

F. Related Documents and Sections:

1. Section 115213 – Projection Screens
2. Section 270528.29 – Hanger and Supports for Communications Systems
3. Section 271513 – Communications Copper Horizontal Cabling.
4. Section 271523 – Communications Coaxial Horizontal Cabling.
5. Section 271533 – Communications Optical Fiber Horizontal Cabling.
6. Section 275114 – Cable Television Transmission and Reception Equipment.
7. Document 00200 – Instructions to Bidders.
8. Document 00210 – Supplementary Instructions to Bidders.
9. Document 00700 – General Conditions.
10. Document 00800 – Supplementary Conditions.
11. Division 01 – General Requirements Sections
12. Division 09 - Finishes
13. Division 12 – Furnishings
14. Division 23 – Heating, Ventilation and Air Conditioning (HVAC) – See Separate Index
15. Division 26 – Electrical – See Separate Index
16. Division 27 – Telecomunications
17. Division 28 – Electronic Safety and Security – See Separate Index

1.2 REFERENCES

A. Reference Standards: See Section 014200 – References. In addition to requirements shown or specified, comply with applicable provisions of the following for design, materials, fabrication, and installation of component parts:

1. BICSI/InfoComm, Audiovisual Design Reference Manual.
2. InfoComm, AV Installation Handbook.
3. InfoComm, Audiovisual Best Practices.
4. Maltese, AV 9000: Defining Quality in Engineered Audio Visual Systems, 2006.
5. City and State or District Ordinances, as applicable to location.
6. IEEE C2, National Electrical Safety Code®.
7. NFPA-70, National Electrical Code®.
8. NFPA-72, National Fire Alarm Code®.
9. NFPA-101, Life Safety Code®.

10. NFPA-255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
11. American National Standards Institute (ANSI).
12. Federal Communications Commission (FCC).
13. National Electrical Manufacturers Association (NEMA).
14. Occupational Safety and Health Administration (OSHA).
15. Uniform Building Code (UBC).
16. City and other local codes and requirements.

B. Work shall comply with the latest edition of applicable criteria, standards, and codes including subsequent addendums.

C. In the event of conflicts, the more stringent provisions shall be applied.

1.3 DEFINITIONS

A. Definitions: See Section 014200 – References for additional definitions.

1. Code Requirements: Minimum requirements.
2. Final Acceptance: Owner's Representative's acceptance of project from Contractor.
3. Furnished by Others: Receive delivery at job site or where called for and install.
4. Owner's Representative: Architect or Engineer having contract directly with Owner for professional services.
5. Relocate: Disassemble, disconnect, and transport equipment to new locations, then clean, test, and install ready to use.
6. Replace: Remove and provide new item.
7. Rough-in: Pipe, duct, conduit, equipment layout and installation.
8. Provide: Furnish and install.
9. Authority Having Jurisdiction (AHJ): Federal, state, local, or other regional department, or individual having statutory authority.
10. Systems Contract Documents: These specifications and drawings referred to herein are furnished with and are integral parts of this system construction document. The specifications and drawings shall remain the property of the Owner and shall be returned by unsuccessful bidders.
11. Specification Information Requests: Direct requests for clarification, substitution, or changes in these specifications or drawings to the Owner.
12. Custom: Indicates systems or components that shall be fabricated by the Contractor based on these specifications and drawings.

13. Owner Furnished Equipment (OFE): Provide for removal, relocation and testing prior to installation. Coordinate the integration of existing components or new components, provided by the Owner into the audiovisual system. Provide required mounting hardware, rack panels, cable, connectors, etc. to ensure proper operation of the OFE systems as specified.

14. Not In Contract (NIC): Refers to work or equipment that is not in contract covered in this section.

15. Future Equipment: Indicates equipment that will be added to the systems by the Owner or Owner representative at a later date. Provisions shall be made for this equipment.

16. Or Equal: Indicates equal in materials, size, color, design, function, and performance of specified and conforming with base bid manufacturer/model.

1.4 CONTRACTOR QUALIFICATIONS

A. Be a licensed dealer for equipment described in these documents and maintain a service department within 75 miles of the project site capable of maintaining those systems both on a component and a complete systems level.

B. Have direct experience on 5 recent projects of similar type and size.

C. Own and maintain the tools and equipment necessary for successful installation and testing of systems as detailed herein and have personnel who are adequately trained in the use of such tools and equipment.

D. Employ at least one control system programmer certified by the manufacturer of the control system utilized in the project.

E. Employ at least one engineer holding a current Certified Technology Specialist – Design (CTS-D) certification by InfoComm International. The engineer shall be assigned to oversee technical aspects of the project [and shall stamp all drawing submittals with a current CTS-D stamp].

F. Employ at least one technician holding a current Certified Technology Specialist – Installation (CTS-I) certification by InfoComm International. The technician shall be assigned as the lead field technician overseeing the installation.

1.5 SYSTEM DESCRIPTION

1.6 SUBMITTALS

A. General:

1. Comply with Section 013300 – Submittals

2. In addition to requirements specified in Section 013300, submit electronic copies of submittals in PDF format.

B. BID SUBMITTAL

1. Schedule of Values: Provide a Schedule of Values and quantities for equipment to be supplied. Each piece of equipment shall be individually priced. Equipment costs shall reflect required modifications and accessories. Equipment schedules in Part 3 should be used for bid submission.

2. Non-Equipment Costs: Furnish the total non-equipment and Service cost and separately a list of non-equipment costs for each area, by the following categories:

    a. Engineering: Including required design, drawings, run sheets, instruction manuals, etc.

    b. Pre-Installation: Including fabrication, modification, assembly, rack wiring, etc., performed on the Contractor's premises.

    c. Installation: Including on-site installation and wiring, coordination and supervision, testing, checkout, Owner training, etc., performed on the Owner's premises.

    d. Software Development: Including required design, testing, debugging, documentation, etc.

    e. Documentation: Including equipment manuals, as-built drawings, software instruction manuals and program listings, user instruction panels, etc.

    f. Training: Including training sessions with owner staff as noted in this specification.

    g. General and Administrative: Including G & A expenses, shipping, insurance, and guarantees.

    h. Project Management: Including weekly written reports, project schedule management, and resource management.

    i. Warranty and first years' service.

    j. Taxes: Including applicable Local, State, and Federal taxes.

3. Service Contract:

    a. Submit cost for a separate one-year service contract for the second year maintenance, covering installed systems, new and Owner-furnished. Include in this contract quarterly site visits to inspect, repair, and adjust systems to restore them to as-new operation. Parts and shop labor are assumed to be additional charges beyond the scope of this contract. This service contract shall commence immediately after expiration of the warranty period. The cost for this service contract shall not be commingled with the costs for the systems base bid.

    b. Submit separate costs for "on-call" service, both in-house and in-shop.

4. Substitutions:

    a. Comply with Section 012300 – Alternates.

    b. Submit bids on the basis of the specified equipment. Submit proposals for substitutions with associated equipment costs, separate and apart from the costs of the equipment as specified.

    c. Proposals for substitutions 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.

    d. Proposals for substitutions shall be accompanied by full technical information, and specifications for the equipment so proposed.

    e. Under no circumstances shall the Owner's Representative be required to prove that an item proposed for substitution is not equal to the specified item. The Contractor shall

submit to the Owner's Representative evidence to support the contention that the item proposed for substitution is equal to the contract specified item. The Owner's Representative's decision as to the equality of substitution shall be final.

5. System Enhancements:

    a. Submit recommendations that will enhance the performance of the system, or reduce costs without loss of performance, in the bid submission. Suggestions that are of value to the Owner will be taken into consideration in the evaluation of the bid returns.

    b. Such proposals shall be made as "alternates", with the appropriate cost modifications shown separate and apart from the costs of the system "as specified".

6. Contractor Resume:

    a. A list of five recently completed projects of similar type and size with contact names and telephone numbers for each.

    b. A technical resume of experience for the Contractor's Engineer, Project Manager, Control System Programmer, Lead Field Technician and any other relevant personnel who will be assigned to this project.

    c. A list of technical product training attended by the Contractor's personnel that will install the systems.

    d. A list of subcontractors providing services under this scope of work. Provide description of work to be performed by each subcontractor and their qualifications.

7. Exceptions: Make exceptions to these specifications and related drawings with the bid submission. In the absence of exceptions, these specifications and related drawings shall be binding in letter and intent. It will further be assumed that the design and specifications have been examined in detail, and full responsibility for the performance of the complete installation as designed and specified is accepted.

8. Project Approach:

    a. An outline of the project approach and availability of resources.

    b. A scheduling plan with the bid return indicating the various pertinent terminal dates after award of contract for completion of design, pre-installation work, on-site installation work, and testing and acceptance.

9. Test Equipment: A list of test equipment, giving make and model numbers to be used for tests and acceptance testing.

C. Installation Submittal

1. Provide after the award of contract, but prior to equipment procurement and installation

2. Shop drawings and data sheets shall be provided as a single comprehensive package. Partial submittals shall one be accepted with prior consent form the Owner's Representative.

3. Shall include, but not be limited to, the following:

    a. System wiring diagrams for video, audio, and control systems showing manufacturer and model numbers, connectivity, cable types and cable identifiers including ancillary devices.

Clearly label each item of equipment shown on the drawing with the manufacturer's terminal number or input/output designation.

b. Plate and Panel drawings showing finish, color, exact lettering, connectors and other pertinent fabrication instructions for all custom plates and panels in the systems. Include physical samples of engraving, finish and color.

c. Rack Elevation drawings showing equipment layout within each rack, rack accessories, and power/grounding layout within each rack.

d. Floor Plans, Reflected Ceiling Plans, Elevation and Sectional View drawings showing the layout for audiovisual devices within the facility.

e. Run sheets or field wiring drawings: Clearly show at each terminal point the type of connector to be used and include typical wiring details of each connector. Note where shields are connected and where they will float to ensure the integrity of the grounding system. Call out wire types and color codes where appropriate. Assign wire numbers and patchbay locations to every wire and patch point in the drawing.

f. Detail drawings including:

   1). Custom furniture and millwork.

   2). Custom components, assemblies and circuitry.

   3). Custom equipment mounting.

   4). Patch Panel Layout drawings.

   5). Unusual equipment modifications

g. Drawing Index and Title Page

h. Symbols Legend

i. Binder containing product data sheets for equipment

   1). Should be organized logically by system

   2). Where a product data sheet includes more than one item, indicate model being proposed.

   3). Provide an index for reference

j. Project schedule including the following milestones:

   1). Submittal packages.

   2). Equipment procurement, indicate equipment with long lead times.

   3). Rack fabrication.

   4). Installation.

   5). Substantial completion.

   6). Acceptance testing.

   7). Owner/user training.

k. Test Equipment: Provide a list of test equipment, including manufacturer, description, and model number, of equipment that is expected to be employed in the test and adjustment of the systems specified.

l. Control System Touch Panel Submittal:

1). Preliminary layouts of all remote control devices (touch panels, remote controls, etc.), submitted on disk and hardcopy.

2). Touch Panel layouts must be done in software supplied by control system manufacturer, such as VisionTools Pro-e. AutoCAD or similar graphics file formats are not acceptable.

3). Descriptions of each button with functionality. Buttons with “trivial” functions, such as help buttons, may be omitted.

4). For each piece of equipment, lists of functions under control of the remote control system.

5). For each piece of equipment, a list of all inputs (feedback) to the remote control system.

D. Substantial Completion Submittal:

1. Shall be provided a minimum of 2 weeks prior to scheduled acceptance testing by the Owner’s Representative and shall include the following:

a. A draft version of Record Drawings for systems depicting the current state of the systems to be tested.

b. A draft version of the Operation and Maintenance manuals which shall include the following:

1). Detailed operation instructions that can be easily understood by non-technical users. Include normal settings for equalizer, amplifier, signal processing, and user-operated controls. Include pictures of touch panel screens when appropriate.

2). A troubleshooting guide for the most common problems that might arise.

3). Equipment list for each room with manufacturer, model number, serial number, client tracking number (if applicable), and other unique equipment numbers for installed equipment in spreadsheet format.

4). A list of fixed or static IP addresses, ISDN numbers and telephone numbers used for audiovisual equipment.

5). A list of frequencies and/or channels used for wireless microphone and assistive listening systems.

6). Recommended maintenance schedule with reference to the applicable pages in the manufacturer's maintenance manuals. Where inadequate information is provided by the manufacturer, provide the information necessary for proper maintenance.

7). A list of necessary and recommended replacement parts for a normal maintenance period of one year.

8). Software files for graphical user interface, source code, DSP, and equipment settings on CD-ROM. Provide electronic copies of compiled and un-compiled programming files.

9). Include the terms of the warranty and the appropriate contact phone numbers for service.

10). Equipment manufacturer's operation and maintenance manuals for each piece of equipment.

c. Test and Measurement Data consisting of:

1). Documentation of the tools and the manner in which the performance tests were taken.

2). Documentation of the performance test results.

3). Documentation of the system settings prior to and after the system set-up.

E. Closeout Submittal

1. Comply with Section 017700 – Closeout Procedures.

2. The Closeout Submittal shall be provided within 30 days of systems acceptance and shall include:

a. Final Project Record Drawings: Submit on CD-ROM in AutoCAD and PDF format. Final Project Record Drawings shall include drawings associated with the systems. The locations of installed conduits shall be shown on floor plan drawings.

b. Two copies of the Final Operation and Maintenance manuals as described in Substantial Completion Submittal.

c. A systems information packet shall be mounted in each equipment rack and shall consist of the system drawings associated with the rack, important telephone numbers and a list of equipment in the rack with serial numbers.

d. Manufacturers' instruction manuals for items of equipment, incorporating or followed by manufacturers' warranty statements.

1). Where manufacturer's registration is required, register warranty in Owner's name at an address determined by Owner. Provide copy of registration.

1.7 PERFORMANCE STANDARDS

A. Meet the following performance standards with each system, unless restricted by the published specifications of a particular piece of equipment:

B. Audio Signal:

1. Signal-to-Noise Ratio (including crosstalk): 55 dB minimum.

2. Total Harmonic Distortion: 0.1% maximum from 20 Hz to 20,000 Hz.

3. Frequency Response: +/- 1.0 dB, 20 Hz to 20,000 Hz.

C. Audio Reproduction:

1. Signal-to-Noise Ratio (including crosstalk): 55 dB minimum.

2. Total Harmonic Distortion: 1% maximum from 30 Hz to 15,000 Hz.

3. Frequency Response:

   a. Distributed Speech Reinforcement System with 8" diameter loudspeakers: +/- 1.5 dB, a flat response from 125 Hz to 2.5 Hz, rolling off at 6 dB/octave from 125 Hz to 80 Hz, 18 dB/octave below 80 Hz, and at 2 dB/octave above 2.5 kHz, as measured on axis of loudspeakers.

   b. Program Reproduction System Loudspeakers: + 2 dB, a flat response from 63 Hz to 6 kHz, decreasing uniformly from a relative level of 0 dB at 6 kHz to a relative level of -5 dB at 20 kHz as measured on axis of loudspeakers.

4. Sound Output Capability: Provide program levels of not less than 95 dB and speech reinforcement levels of not less than 85dB in the seating area without objectionable distortion, rattles, or buzzes, employing as test signals several different samples of recorded music and microphones applied at each system input.

5. Hum and Noise: Hum and noise shall be inaudible (below the background noise level of the space) under normal operation and as observed in normal seat locations.

D. Video Signal:

1. Signal-to-Noise Ratio (peak to RMS) Unweighted DC to 4.2 MHZ: 55 dB minimum

2. Crosstalk: Crosstalk (unweighted DC to 4.2 MHz): 45 dB minimum

3. Frequency Response: Within plus-or-minus 0.5 dB to 4.2 MHz.

4. Line and Field Tilt: 2% minimum

5. Differential Gain: 3% maximum

6. Differential Phase: 2o maximum

E. Video Timing:

1. System Timing: Sync coincidence within 50 nanoseconds

2. Color Timing: Within 2o at 3.58 MHz

F. Optical: Optical projection systems shall meet the following performance standards:

1. The total averaged light output from a projector, in lumens, shall be within plus-or-minus 15% of that specified by the projector manufacturer.

2. The light fall-off from the center of the projected image to four corners, as measured at the projected image plane, shall not exceed 50% for video projector images nor 35% for slide projector images.

3. 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.

1.8 DELIVERY, STORAGE AND HANDLING

A. Bear costs of shipping to the site, and of unusual storage requirements. Make appropriate arrangements, and coordinate with authorized personnel at the site, for the proper acceptance, handling, protection, and storage of equipment so delivered.

1.9 ADDITIONAL ENGINEERING SERVICES

A. In the event that the Owner's Representative is required to provide additional engineering services as a result of substitution of equivalent materials or equipment by the Contractor, or changes by the Contractor in dimension, weight, power requirements, etc., of the equipment and accessories furnished, or if the Owner's Representative is required to examine and evaluate changes proposed by the Contractor for the convenience of the Contractor, then the Owner's Representative's expenses in connection with such additional services shall be paid by the Contractor and may be deducted from monies owed to the Contractor.

B. In the event that the Owner's Representative is required to provide additional engineering services as a result of Contractor's errors, omissions or failure to conform to the requirements of the Contract Documents, or if the Owner's Representative is required to examine and evaluate changes proposed by the Contractor solely for the convenience of the Contractor, then the Owner's Representative's expense in connection with such additional services shall be paid by the Contractor and may be deducted from monies owed to the Contractor.

C. In the event that the Owner's Representative is scheduled to visit the project site to validate proper system performance before the Contractor has tested and setup all systems in accordance with this document, then the Owner's Representative's expense in connection with such additional services shall be paid by the Contractor and may be deducted from monies owed to the Contractor.

1.10 WARRANTY

A. Comply with Section 017700 – Closeout Procedures.

B. For a period of one year from completion of the project, affect replacement or substitutions of equipment within 24 hours of first notification. Complete repairs to equipment within 72 hours. If repairs cannot be completed during this time period, or if ordering of parts is required, forward to the Owner every 72 hours documentation of progress of repairs. This repair capability is mandatory. Include costs anticipated to comply with this requirement in the bid.

C. Contractor shall be responsible for and make good, without expense to the Owner defects arising during this warranty period that are due to imperfect materials, equipment, improper installation or poor workmanship.

D. Activate manufacturer's equipment warranties in Owner's name to commence on the date of acceptance. In the case of Contractor- modified equipment, the manufacturer's warranty is normally voided. In such cases, provide the Owner with a warranty equivalent to that of the original manufacturer.

E. Include in the warranty quarterly site visits to check and adjust equipment and restore systems to original performance standards.

F. Provide a service visit one month prior to the warranty expiration to confirm the correct working condition of the system and to make necessary adjustments to bring the system back to optimal working condition. Include costs anticipated to comply with this requirement in the bid.

PART 2 PRODUCTS

2.1 GENERAL

A. Discrepancies among the contract documents shall be submitted to the Owner's Representative or the most stringent case shall be assumed.

2.2 SPECIFIC EQUIPMENT

A. Reference Schedule A, "Equipment List"

B. Schedule A is intended to present the major components of the systems and to provide information on the quantities of equipment and systems to be installed. Provide additional equipment and accessories as required to produce a complete and functional system consistent with the design intent.

C. To ensure that the latest technology equipment is provided to the project, at the time of installation supply the latest model of the product which is available for each piece of equipment.

D. Should there be a difference in pricing between the equipment model cost at the time of bid and the pricing for the latest equipment model to be provided at the time of installation, the price differential will be compensated accordingly.

E. Materials: Supply materials and equipment that shall be new and shall meet or exceed the latest published specifications of the manufacturer.

2.3 CABLES

A. Cables must be manufactured and installed in compliance with local and state codes.

B. Cable Passing through two or more floors: Rated, listed and marked for use in riser application.

1. Riser Cable: CMR or OFNR rated per NEC and comply with other applicable codes.

C. Cable in Plenums: Rated, listed and marked for use in plenum application.

1. Plenum Cable: CMP rated per NEC and comply with other applicable codes.

D. Contractor shall verify all spaces as plenum or non-plenum with the architect/mechanical engineer prior to purchasing or installing any cable. Contractor shall be aware of any owner or AHJ requirements for plenum cable or other cable types.

E. Twisted Pair Horizontal Cabling:

1. Refer to Section 271500 – Communications Copper Horizontal Cabling.

2. Microphone and Line Level Cables: Provide #22 AWG Shielded Twisted Pair Cable.

3. High-Impedance Loudspeaker Cables: Provide #16 AWG Unshielded Twisted Pair Cable.

4. DC Power Cables: Provide #16 AWG Unshielded Twisted Pair Cable.

5. Low-Impedance Loudspeaker Cables: Provide #12 AWG Unshielded Twisted Pair Cable.

6. RS-232/RS-422/RS-485 Control Cables: Provide Shielded Data Cable.

7. Data/Power Cables: Provide Data/Power Cable.

8. UTP Cable: Provide Category 6 UTP Cable.

F. Digital Cabling:

1. HDMI Cables: Provide HDMI specification 1.4 compliant cables.

G. Coaxial Horizontal Cabling:

1. Comply with Section 271500 – Communications Coaxial Horizontal Cabling.

2. The following distance guidelines shall be used for baseband video cable selection:

a. Series 11/U where lengths between active devices are between 45.72 m (150 feet) and 91.5 m (300 feet).

b. Series 11/U or Series 6/U where lengths between active devices are between 15.24 m (50 feet) and 45.72 m (150 feet).

c. Series 11/U, Series 6/U, or Series 59/U where lengths between active devices are 15.25 m (50 feet) or less.

H. Video Cables (Series 59/U): Provide Series 59/U – Coaxial Video Cable.

I. Video Cables (Series 6/U): Provide Series 6/U – Coaxial Video Cable.

J. Video Cables (Series 11/U): Provide Series 11/U – Coaxial Video Cable.

K. S-Video Cables:

1. When lengths of S-video cable between active devices exceed 30.5 m (100 feet) use individual Series 6/U video cables.

2. When lengths of S-video cable between active devices are 30.5 m (100 feet) or less provide Series 6/U or Series 59/U – S-Video Coaxial Cable.

L. RGBHV Cables (Series 59/U):

1. Five individual video cables, color-coded, in overall jacket.

2. Comply with Series 59/U – Coaxial Video Cable.

M. RGBHV Cables (Series 6/U):

1. Five individual video cables, color-coded, in overall jacket.

2. Comply with Series 6/U – Coaxial Video Cable.

N. Optical Fiber Cable:

1. Refer to Section 271523 Communications Optical Fiber Horizontal Cabling.

2.4 CONNECTORS

A. Audio connectors of XLR, 3.5 mm (1/4 inch), and RCA types shall be solder type and incorporate metal shells and bodies. Acceptable manufacturers: Switchcraft or Neutrik.

B. Video connectors of BNC and RCA shall be:

1. Dual crimp or compression style nickel plated brass connector utilizing a gold plated center contact.

2. Connector and pin appropriately selected based on the specified cable as part of a manufacturer's approved assembly.

3. Crimp or compression tool and die sets utilized shall be approved by the manufacturer for the assembly.

4. Color coded via strain relief boot, isolation bushing or O-ring to designate video type. Color designations shall be as follows:

a. RGBHV

1). R: Red

2). G: Green

3). B: Blue

4). H: Black

5). V: White

b. YPbPr

1). Y: Green

2). Pb: Blue

3). Pr: Red

c. S-Video

1). Y: White

2). C: Yellow

d. Composite Video: Yellow

e. SDI/HD-SDI: Orange

5. Acceptable manufacturers: ADC, Extron, Tyco, Kings, Bomar, Canare, or Trompeter.

C. Use only rosin core solder or approved mechanical connectors for joints and connections within the system. Twist-on wire-nuts are not acceptable.

D. Terminator: Provide 75Ω terminators where required.

E. UTP Connectors: Refer to Section 271500 – Communications Horizontal Cabling.

F. Fiber Optic Connectors: Refer to Section 271543 – Communications Faceplates and Connectors.

2.5 EQUIPMENT RACKS

A. Locate equipment to allow proper airflow and ventilation. Provide ventilation to ensure rack temperatures do not exceed 95 degrees Fahrenheit after 5 hours of continuous operation.

B. Provide low-noise ventilation when racks are open to work areas.

C. Cable lacing bars shall be used for horizontal cable management.

D. Use only rack screws with nylon anti-scuff washers.

E. Key locking doors identically.

F. Fill empty rack spaces with flanged, 3.2 mm (0.125 inch) thick aluminum, standard rack size, brushed black anodized finish blank panels, unless otherwise noted.

G. Provide and install security covers to restrict access to equipment with front panel controls that do not require adjustment by the end user.

H. Provide a custom rack panel recognizing both the design firm and the integration firm. The panel shall have the firms' logos and contact information on it. Provide a logo panel at each separate location in the project.

I. Panels mounted on the rear rack rails shall not block access to front mounted components or conflict with vertical cable management.

J. Provide rack shelves for ancillary equipment.

2.6 INTERFACES

A. Audio: Provide level interfaces for sources not having nominal plus 4dBu, balanced inputs and outputs.

B. Auxiliary Interfaces:

1. Provide one cable with molded connectors for each auxiliary audio, video, and control interface location provided as specified herein, unless noted otherwise on the Drawings.

2. Cables shall be flexible.

3. Where multiple formats are typically utilized together cables shall include all formats within a single jacket, included but not limited to, VGA with mini-TRS, Composite Video with Stereo Audio, and Component Video with Stereo Audio.

4. Provide the following length cables, unless noted otherwise on the Drawings:

a. Rack Mounted Interface: 3.6 m (12 feet).

b. Wall Mounted Interface: 3.6 m (12 feet).

c. Floor Mounted Interface: 3.6m (12 feet).

d. Table Mounted Interface: 1.8 m (6 feet).

5. Provide manufacturer's adapter plates for pass-through connections as indicated on the Drawings.

6. Extra Materials:

a. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

b. Provide one of each type for every ten required, but not less than one.

2.7 CUSTOM FABRICATION

A. Electrical Power Connections: Electrical power junction boxes and circuits will be provided by others. Provide required interconnections to the power system from these junction boxes to the equipment and equipment racks.

B. Equipment Rack: Provide power receptacle strips, with "U" ground outlets. Power receptacle strips shall be mounted on the rear interior of the rack space on the left side as viewed from the rear. Insulate power receptacle strips from the rack. Power receptacle strips shall be SGL Waber Company or approved equal. Provide UL-approved incandescent work light mounted on the upper left interior panel of each equipment rack.

C. Project Information Label: Permanently mount, at the top facing edge of each equipment rack, an engraved plastic laminate plate, with filled lettering on contrasting background. Plate shall identify "Design by Arup. Installation by: Contractor, City, ST."

D. Audio Transformers: Provide appropriate impedance ratio and power handling capacity for the function intended of audio transformers specified in the system.

E. Labeling: Provide permanently mounted 1/32" thick by 1/4" high black lamicoid or anodized, brushed aluminum labels with 1/8" engraved lettering for each piece of equipment and every user-adjustable control and input on the audiovisual equipment.

F. Rack Mount Adapters and Security Covers: Provide the appropriate factory or custom rack mount adapters for equipment installed in the audiovisual equipment rack, whether specifically itemized or not. Provide security covers for equalizers, crossovers, signal delays, and other adjustable signal processors.

G. System Functional Diagrams: Provide reduced-size as-built functional diagram for the control, audio and video system. Frame with acrylic cover, or laminate drawing, and mount adjacent to equipment rack.

H. Seismic Safety: Mount and brace permanently installed equipment to the building structure to minimize potential damage to personnel or equipment from foreseeable seismic events. Physically bolt audiovisual equipment racks to the floor to prevent toppling. Brace hanging equipment such as loudspeakers, et cetera both to minimize sway and to prevent detachment from the overhead structure.

2.8 OPEN-TOP CABLE SUPPORT (J-SUPPORT)

A. Comply with Section 270528.29 – Hanger and Supports for Communications Systems

2.9 MISCELLANEOUS EQUIPMENT

A. Provide screws, anchors, clamps, tie wraps, wire molding, miscellaneous grounding and support hardware necessary to facilitate installation of the system.

B. Provide specialized tools not readily available on commercial tool market for assembly, adjustment, or maintenance of systems' components.

C. Furnish special installation equipment or tools necessary to properly complete system. This may include, but is not limited to, tools for terminating cables, test equipment for audiovisual devices, jack stands for cable reels, and cable winches.

D. Provide equipment with suitable lifting attachments to enable equipment to be lifted in its normal position. Lifting attachments shall be able to withstand handling conditions that might be encountered, such as rapid lowering and braking of load, without bending or distortion of shape.

E. Electrical Power Connections: Electrical power junction boxes and circuits will be provided by others. Provide required interconnections to the power system from these junction boxes to the equipment and equipment racks.

F. Equipment Rack: Provide power receptacle strips, with "U" ground outlets. Power receptacle strips shall be mounted on the rear interior of the rack space on the left side as viewed from the rear. Insulate power receptacle strips from the rack. Power receptacle strips shall be SGL Waber Company or approved equal. Provide UL-approved incandescent work light mounted on the upper left interior panel of each equipment rack.

G. Project Information Label: Permanently mount, at the top facing edge of each equipment rack, an engraved plastic laminate plate, with filled lettering on contrasting background. Plate shall identify "Design by Arup, City, ST. Installation by: Contractor, City, ST."

H. Audio Transformers: Provide appropriate impedance ratio and power handling capacity for the function intended of audio transformers specified in the system.

I. Networks and Pads: Provide networks and pads as shown on the drawings or as required to achieve proper impedance matching and levels. Networks and pads shall be balanced. 0.5 watt, 5% composition resistors shall be soldered to fixed connection points at each end.

J. Loudspeaker Enclosures: Loosely fill with glass fiber to 2 lbs/cu. ft. density prior to installing loudspeakers.

K. Rack Mount Adapters and Security Covers: Provide the appropriate factory or custom rack mount adapters for equipment installed in the audiovisual equipment rack, whether specifically itemized or not. Provide security covers for equalizers, crossovers, signal delays, and other adjustable signal processors.

L. System Functional Diagrams: Provide reduced-size as-built functional diagram for the control, audio and video system. Frame with acrylic cover, or laminate drawing, and mount adjacent to equipment rack.

M. Seismic Safety: Mount and brace permanently installed equipment to the building structure to minimize potential damage to personnel or equipment from foreseeable seismic events. Physically bolt audiovisual equipment racks to the floor to prevent toppling. Brace hanging equipment such as loudspeakers, et cetera both to minimize sway and to prevent detachment from the overhead structure.

N. Owner-Furnished Equipment (OFE): Accept equipment upon removal, perform a general cleaning, test for proper operation, and install in accordance with project guidelines.

O. Coordinate return or recycling of removed and/or replaced equipment with Owner. Existing equipment not reused shall be returned to the Owner. The Contractor is required to properly recycle or dispose of equipment at no additional charge at Owner’s request.

PART 3 EXECUTION

3.1 GENERAL

A. Installation shall include:

1. Delivery, unloading and setting in place of equipment.

2. Fastening equipment to walls, floors, ceilings, or other structure as required.

3. Interconnecting wiring of the system components.

4. Equipment alignment and adjustment.

5. Other work required to result in complete and operational systems.

B. If in the opinion of the Contractor, an installation practice is desired or required, which is contrary to these specifications or drawings, a request for modification shall be made in writing to the Owner's Representative. Modifications shall not commence without written approval from the Owner's Representative.

C. Prevent and guard against electromagnetic and electrostatic interference, and install the equipment to provide safety for the operator.

D. Coordinate ordering and installation of equipment with long lead times or having a major impact on work by other trades so as not to delay the job or impact the schedule.

E. All equipment shall be installed in accordance with manufacturer's instructions.

F. Provide access to equipment and components requiring operation, service or maintenance within the life of the system.

G. Verify correctness of parts list and equipment model numbers and conformance of each component with manufacturer's specifications.

H. No equipment shall be hidden or covered up prior to inspection by the Owner's Representative. Work that is determined to be unsatisfactory shall be corrected immediately.

I. The contractor shall be responsible for damage to surface or work disrupted as a result of contractor's work. Repair of surfaces, including painting, and patching, shall be included as necessary.

J. Edges of holes which cables pass through shall be covered with rubber or nylon grommets.

K. Equipment and enclosures shall be mounted plumb and square.

3.2 WORKMANSHIP

A. Materials and standards shall meet or exceed industry standards and be fully guaranteed for one full year from final acceptance.

B. Cable integrity and associated terminations shall be thoroughly inspected, fully tested and guaranteed as free from defects, transpositions, opens-shorts, tight kinks, and damaged jacket insulation.

C. Labor must be thoroughly competent and skilled, and work shall be executed in strict accordance with the best practices of the trade.

D. Installation shall be done in conformance with the manufacturers' design and installation guidelines. Failure to follow the appropriate guidelines will require the Contractor to provide in a timely fashion the additional material and labor necessary to properly rectify the situation.

3.3 EXAMINATION

A. General: Examine conditions and proceed with work in accordance with Section 014000 – Quality Requirements.

B. Examination of Premises: Visit Site to become familiar with local conditions under which work is to be performed and correlate observations with requirements of Contract Documents. No allowance shall be made for claims for concealed conditions which Contractor, in exercise of reasonable diligence in observations of site and local conditions, should have learned of.

C. Verify that electrical requirements including junction boxes, floor boxes, ceiling loudspeaker enclosures, empty conduit and power circuits and receptacles are in place as shown on the drawings.

D. Inspect and review related electrical work to verify correct voltage, polarity, and grounding prior to interfacing power with audiovisual equipment.

E. Before ordering materials or doing work, verify measurements and be responsible for correctness of same.

1. No extra charge or compensation allowed for duplicate work or material required because of unverified difference between actual dimension and measurement indicated on Drawings.

2. Submit discrepancies found in writing to Owner's Representative for consideration before proceeding with Work.

F. Facility Review: Conduct walk through with Owner's Representative of work areas, describing specific work methods and proposed schedules, before commencing work, enabling Owner's Representative to identify areas of concern, desired installation timetables and review important procedural and safety precautions.

G. Prior to start of installation, meet at project site with Owner's Representative and other trades performing related work to coordinate efforts. Review areas of potential interference and resolve conflicts before proceeding with work.

H. Examine areas and conditions under which system is to be installed. Do not proceed with work until satisfactory conditions have been achieved. Notify Owner's Representative if conditions are unacceptable and schedule will be affected.

I. The Drawings are diagrammatic in nature and, unless explicitly dimensioned, indicate approximate locations of equipment and components. Changes in the location, and offsets of equipment and components which are not shown on the Drawings but are necessary in order to accommodate building conditions and coordination with the work of other trades, shall be made prior to installation, without additional cost.

3.4 ROUGH-IN

A. Before construction work commences, visit site and identify exact routing for pathways. Identify required core locations.

B. Equipment Locations: Coordinate with other trades, other renovation projects, and existing conditions to eliminate interference with required clearances for equipment maintenance and inspections.

1. Provide easy, safe, and code mandated clearances at equipment racks and enclosures, and other equipment requiring maintenance and operation. If it is determined that ample maintenance and passage space has not been provided, rearrange work and/or provide other equipment as required for maintenance space.

2. Coordinate work with other trades and existing conditions to determine exact routing of cable tray, hangers, conduit, etc., before fabrication and installation. Where more than one trade is involved in area, space, or chase, cooperate to utilize space appropriately in relation to their individual requirements.

3. Coordinate work in open ceilings. Where cable tray, hangers, conduits, cables are exposed route infrastructure perpendicular to finishes and other building systems. Route infrastructure to reduce locations where trade work transition from/to exposed areas.

4. Bring changes in size or location of material or equipment necessary to meet field conditions or in order to avoid conflicts between trades to immediate attention of Owner's Representative before such alterations are made.

5. Verify with Owner's Representative exact location and mounting height of equipment in finished areas, such as equipment racks, communication, and electrical devices.

3.5 MOUNTING REQUIREMENTS

A. Work shall be installed level and plumb, parallel and perpendicular to other building systems and components.

B. Permanently attach equipment to the building structure with a minimum safety factor of 5 . Suspended components that move or are otherwise subjected to continuous wear or friction shall be supported with a minimum safety factor of 8 . When a higher safety factor is recommended by an equipment manufacturer or required by the AHJ, the more stringent requirement shall be met.

C. Do not attach equipment in a manner that weakens or overloads the building structure.

D. Attain the stamped approval of a licensed Structural Professional Engineer for equipment that is attached in a manner or location that could impact the integrity of the building structure or cause personal injury.

E. Install equipment with the ability for minor adjustment as required for optimization.

F. Loudspeaker enclosures shall be supported from the building structure, or from the ceiling suspension system in acoustical tile ceilings with a safety wire fastened to the building structure.

G. Give consideration, not only to operational efficiency, but also to overall aesthetic factors in the installation of equipment and cable.

3.6 PENETRATIONS

A. Conduit and Sleeve Openings: Shall be waterproofed and fireproofed in compliance with applicable codes and regulations.

B. Firestopping: Fire-stop openings and penetrations through fire and smoke rated wall and floor assemblies in accordance with Section 078413 – Firestops and Smokeseals.

1. Fire-stop System Inside of Conduits:

a. Use only dielectric, water resistant, non-hardening, permanently pliable/re-enterable putty along with appropriate damming or backer materials.

b. Use sealant capable of being removed and reinstalled.

c. Sealant shall adhere to penetrants and common construction materials and be capable of allowing normal wire/cable movement without being displaced.

2. Add fire-stop pillows rated for sealing existing cable tray penetrations through firewall.

3. Patch openings remaining around and inside conduit, sleeves, and cable penetrations to maintain integrity of fire rated assembly.

3.7 ELECTRICAL POWER, GROUNDING AND BONDING

A. Provide a ground bus bar bonded to each equipment rack. Terminate the bus bar to the audiovisual technical ground. Ground the chassis of each piece of equipment not utilizing a 3-prong power cord to the bus bar.

B. For active equipment, float the ground wire at the output side of balanced audio lines other than microphone lines or intercom and where required by manufacturer.

C. Carry audio shields straight through passive devices such as patch panels and terminal strips.

D. Arrange inner-rack power distribution so that no circuit exceeds 80% of full power.

E. When the electrical service to a rack is hardwired, the Contractor shall terminate inner-rack power wiring to a j-box at the top or bottom of the rack for field connection of the electrical service.

F. Ground control lines in compliance with the manufacturer’s specification for the appropriate equipment.

G. No power cord from equipment shall have its third prong (ground) removed or defeated.

H. Label each outlet within each rack to reflect which circuit is feeding it.

I. Establish only one ground connection path between equipment in the system.

J. Do not place audiovisual distribution cabling alongside power lines or share the same conduit, channel or sleeve with electrical apparatus.

K. Provide cable service loops at devices for inspection, minor adjustment, and future flexibility.

L. Grounding Procedures: In order to minimize problems resulting from improper grounding, and to achieve maximum signal-to-noise ratios, adhere to the following grounding procedures:

1. General: Because of the great number of possible variations in grounding systems, follow good engineering practice, as outlined above, and deviate from these practices only when necessary to minimize crosstalk and to maximize signal-to-noise ratios in the audio, video, and control systems.

2. System Grounds: Establish a single primary "system ground" for the systems in each particular area. Connect grounding conductors in that area to this primary system ground. Provide the system ground in the audio equipment rack for the area. The ground shall consist of a copper bar of sufficient size to accommodate secondary ground conductors.

3. Rack Ground:

   a. Connect the No.6 insulated copper wire connected to the earth ground to the primary system ground busbar in the Equipment Rack.

   b. Bond a No.12 TW stranded wire from the Equipment Rack frame to the primary system ground bus bar.

4. Equipment Grounds: Grounding methods used will be dependent upon individual equipment interconnection of chassis ground, circuit common, and power supply common within the units. Provide ground method for equipment types as follows:

   a. Equipment having a 3-wire power cord with green wire of the power cord connected to chassis (Signal common is not internally connected to chassis): Make no connection from chassis ground to primary systems ground busbar in Equipment Rack.

   b. Equipment having a 3-wire power cord with green wire of the power cord connected to chassis: Make no connection from chassis ground to primary system busbar, but do make connection with 14AWG insulated wire from circuit common to primary system ground busbar in Equipment Rack. Separate circuit common from chassis ground.

   c. Equipment having a 2-wire power cord, no green wire, neutral is not tied to chassis, and circuit common is tied to chassis: Make connection from chassis to primary system ground busbar using 14AWG insulated wire.

5. Audio Cable Shields: Ground audio cable shields at one point only. There are no exceptions. For inter- and intra-rack wiring connect the shield at one end only, this shall be at the input to a device. The shield shall be lifted at the device output. For ungrounded portable equipment, such as microphones, the shield shall be connected at both ends but grounded at only one end.

6. Video Receptacles: Insulate video receptacles from the panel, outlet box, or wireway. Unless otherwise detailed herein, use insulated-from-panel type receptacles.

3.8 CABLE INSTALLATION:

A. Comply with Section 271500– Communications Copper Horizontal Cabling.

B. Mark cables, regardless of length, with permanent, non-handwritten number or letter cable markers within six inches of both ends. There shall be no unmarked cables in the system. Marking codes used on cables shall correspond to codes shown on drawings and/or run sheets.

C. Furnish screw-type terminal blocks, boards, strips, or connectors, for cables which interface with racks, cabinets, consoles, or equipment modules. Terminate wires terminating at screw-type terminals with crimp-on lugs. "Telephone-style" punch-down blocks are not acceptable for signal or data wiring.

D. Group cables according to the signals being carried. In order to reduce signal contamination, form separate groups for the following cables:

1. Power cables
2. Control cables, Broadband RF cables, CAT-5/6 Data Cables, Video cables, Camera cables
3. Audio cables carrying mic and line level signals
4. Audio cables carrying loudspeaker signals
5. (Fiber cables may be grouped with any of the other cable types.)

E. Cut cables (except video and camera cables that must be cut to an electrical length) to the length dictated by the run. For equipment mounted in drawers or on slides, provide the interconnecting cables with a service loop of appropriate length.

F. Install no cable with a bend radius less than that recommended by the cable manufacturer.

3.9 EQUIPMENT RACKS

A. Perform rack fabrication before delivering the racks to the job site. Only wiring and terminations dependant on external devices shall be done at the job site.

B. Test equipment power and functionality to the fullest extent possible prior to delivering the racks to the job site.

C. Equip the rack with sufficient AC power distribution to support equipment as well as two spare, non-switched, convenience outlets. One convenience outlet is to be readily accessible from the front and one readily accessible from the rear of the rack.

D. Provide service loops within the equipment rack for cables connected to external devices.

E. Locate equipment in racks to comply with ADA guidelines.

F. Install equipment racks level and plumb with the room and with adjacent racks.

G. Organize inner-rack cables in an orthogonal manner and organized into neat harnesses by cable type. The rear of equipment shall be fully visible without an array of cables in the way.

H. As a general practice, run power cables, control cables, and high level cables on the left side of an equipment rack as viewed from the rear. Run other cables on the right side of an equipment rack, as viewed from the rear.

I. Horizontal cable management in rack shall be neatly tied in manageable bundles with cable lengths cut to minimize excessive cable slack, but allowing for service and testing.

J. Provide horizontal support bars if cable bundles sag.

K. Adhesive backed cable tie anchors shall not be used.

L. Velcro style cable wraps shall be used in vertical wire management. Plastic cable ties shall not be acceptable.

M. Arrange unlike signal types in separate harnesses maintaining adequate separation distances to avoid interference.

N. Package spare parts for each device in a clear plastic pouch and attach it to the rear of that device.

O. Allow the Owner's Representative to inspect the racks for approval prior to delivery to the job site.

P. Receptacle Plate Designation: Clearly engrave wall-mounted receptacle plates with alphanumeric identification of input type (i.e., mic, line, speaker, video etc) and corresponding audio or video patch field designation.

Q. Patch Panel Assignments: Wire patch panels so that signal "sources" (outputs from) appear on the upper row of a row pair; and "loads" (inputs to) appear on the lower row of a row pair.

R. Patch Panel Designation Strips: Utilize alphanumeric identifications and descriptive information on audio and video patch panel designation strips. Number the jack positions in each horizontal row sequentially from left to right. Letter the horizontal jack rows sequentially from top to bottom. Include the alphanumeric identification of each jack on the functional block drawings, as well as on reproductions of these drawings which shall be mounted in an appropriate location near the patch bays.

3.10 SYSTEM SETUP AND PERFORMANCE VERIFICATION

A. Preparation:

1. Interior finishes and furnishings shall be in place for these tests.
2. HVAC system is to be balanced and in operation.
3. Confirm complete and proper labeling of system components.
4. Attach reduced-size Block Drawings to a rack in each location.
5. Remove boxes and debris from the project site.
6. Deliver portable and spare equipment to the premises, tested and stored as directed.
7. Tests and adjustments shall be performed in the sequence specified herein.

B. General Setup:

1. Verify that audiovisual related components are free from rough or jagged edges.
2. Verify that rack ventilation is working properly.
3. Verify that systems are free from oscillation and stray RF interference.
4. Test and verify continuity and proper termination of every cable in the system.
5. Following final acceptance of system set-up and performance, equipment with front panel controls, not normally adjusted by the operator shall have the controls disabled or be mounted behind blank panels or be furnished with security panels.

C. Audio System Setup and Testing:

1. Impedance

a. Measure and document the impedance of each loudspeaker circuit at 63 Hz, 250 Hz, 1 kHz and 4 kHz.

b. Measure at the circuit's entry point to the equipment rack.

c. Measurement shall be taken prior to the loudspeaker circuit being connected to the amplifier.

d. Reject and correct measurements that differ significantly from calculated values or fall outside of amplifier specifications.

e. Measure and document the magnitude of impedance at 1 kHz.

2. Polarity

a. Perform polarity checks of loudspeaker lines by means of a polarity tester or use DC source at one end of each line and a voltmeter at the other end. Loudspeaker lines shall be identically polarized with respect to color-coding.

b. Test polarity of the loudspeakers using a sine-wave test signal warbled about 500 Hz. The listener shall be located on axis of the loudspeaker. Switch the loudspeakers from nominally in polarity to nominally out of polarity with respect to the selected loudspeaker. With the loudspeakers in proper polarity, the quality and clarity of the music or speech should be greater, and the warble test signal should clearly come to the surrounding space from the loudspeaker.

3. Ambient Noise

a. Measure and document the ambient noise level in each loudspeaker zone in the system.

b. Ensure that the minimal loudspeaker level is at least 25 dB above the ambient noise level at the furthest listener. At the direction of the Owner's Representative, make additional level adjustments that the space requires.

4. Hum and Noise Level:

a. Measure the hum and noise levels of the overall system for each microphone input channel and line-level input channel.

b. Adjust gain controls for optimum signal-to-noise ratio so that full amplifier output will be achieved with 0 dBm at a line-level input.

c. Terminate line-level inputs with shielded resistors of 150 and 600 ohms, respectively, for these measurements.

d. Disconnect the loudspeaker lines and terminate the power-amplifier outputs with power resistors for these measurements. The value of the load resistor shall be within 5% of the nominal load impedance of the amplifier under test. The power rating of the resistor shall equal the power rating of the amplifier.

5. Wireless Microphones and Accessories:

a. Arrange wireless microphone antennas to provide drop-out free performance over the entire area being served.

b. Set wireless microphone channels for minimum interference from external RF sources and maintain proper channel separation to eliminate adjacent channel interference.

6. Unity Gain:
    a. Bring the system to a unity gain level of plus 4 dBu.
    b. Verify proper gain structure throughout system.
7. Delay:
    a. Using an impulse response measure the arrival time for each loudspeaker zone.
    b. Set-up delay as required providing localization based on the Haas effect. Realizing localization based on level differences will not be accepted.
8. Uniform Coverage: Using pink noise at the nominal operating level as the source and measuring in dBA with a sound pressure level meter at the typical listening height, verify that there is a variance of no more than a plus or minus 3 dB within the listening area.
9. Frequency Response:
    a. Using a dual channel FFT with boundary-plane measurement, adjust equalizers to achieve a the system frequency response described in PART 1.
    b. Take an average of measurements performed at a variety of locations in the room.
    c. Perform this measurement and setup only after furniture and floor, wall, and ceiling treatments have been installed.
    d. Smooth out and adjust the room curve to achieve a desirable response for the most typical source material.
    e. Avoid equalizer settings that result in a 6 dB or greater change from either adjacent band.
    f. Re-take the uniform coverage test and make adjustments as required.
    g. Document both the un-equalized and equalized average frequency response curves of the room and include the graphs in the Project Record documentation.
    h. Properly adjust processing equipment, such as compressors, limiters and feedback eliminators for typical operation.
10. Spurious Noises:
    a. Verify that the system is free from pops, crackle, hum, and other distortion when active controls are operated, in the absence of audio input signal and when the system is driven to full output at 100 Hz.
    b. Using an electronic audio oscillator, slowly sweep through the usable frequency band of the sound system at a level of 6 dB below rated power-amplifier output voltage to each system in order to verify that the system and other building elements are free from buzzes or rattles.
    c. Correct causes of these defects unless the cause is clearly from other than the sound amplification system's equipment and installation, in which case bring the cause to the attention of the General Contractor.
11. THD+N:

a. Measure and document the THD+N at 15 dB above nominal operating level for entire audio system signal chain. Test from output of all line level input device and end with amplifier input cable.

b. Reject and correct measurements that exceed 0.5 % between 40 Hz and 20 kHz.

12. Power-Output and Signal-Level Adjustment within System:

a. Measure the electrical distortion of the overall system for each line-level input channel.

b. Adjust gain control as for the tests specified herein.

c. Apply a 1-kHz sine-wave signal from an oscillator having less than 0.5% total harmonic distortion at the input tested, at a level required to produce full amplifier output. Note that a pad with 150-ohm output impedance is required for driving the microphone-level input in accordance with the EIA standard.

d. Use a distortion analyzer to measure the output level and the total harmonic distortion of the amplification and control equipment. In the absence of a distortion analyzer, a high input impedance-measuring device such as a DMM may be used to measure the output level. Lack of clipping or apparent deformation of a sine-wave input signal at the power-amplifier output, as seen on the oscilloscope, may serve as evidence that distortion of amplification and control equipment is within acceptable limits.

e. Make measurements with loads actually incurred in the system operation. Power-amplifier loads shall be power resistors equal to the nominal load impedance of the output terminals used in the system.

13. Audio Test Signal Paths: Verify operation from source inputs (for microphones, audio tape units, video tape units, etc.) through ADAs, mixers, switchers, etc., to signal destinations.

D. Video System Setup and Testing:

1. Motorized Projection Screens:

2. Video Projectors:

a. Properly align, and focus video projectors.

b. Verify image fills entire screen with proper image geometry.

c. Projected image shall be free of vibrations.

d. Comply with video displays below.

3. Video Displays:

a. Allow video display to warm up for a minimum of thirty minutes with moving images prior to testing and adjustments.

b. Video display adjustments shall be performed using the native resolution at each utilized input of the display.

c. Image sizing:

1). Using a crosshair or crosshatch pattern, adjust the display devices to show a full image at the system resolution.

d. Clock Setting:

1). Using an alternating pixel test pattern, adjust the clock setting until the pixels appear to stand still.

2). Document the value of the onscreen display.

e. Black Level:

1). Properly adjust using a picture line up generating equipment (PLUGE) test pattern.

2). Adjust the brightness control slowly until the black than black bar is just fully extinguished, the remaining vertical bar should be dimly visible.

3). Document the appropriate value of the onscreen display.

f. Gain:

1). Properly adjust using a PLUGE test pattern on the display to be adjusted.

2). Adjust the contrast control until the 100% white bar is at the threshold of maximum brightness without blooming.

3). Document the value of the onscreen display.

4). Perform Black Level and System Gain tests until there is no additional interaction between contrast and brightness control adjustments and document the final onscreen values for contrast and brightness. Document the values of the onscreen display.

g. Color Level:

1). Properly adjust using a SMPTE color bars test pattern.

2). While viewing the blue information only, adjust the color level until the first and last large bar blends with the small patch underneath.

3). Document the onscreen value for color level.

h. Color Phase:

1). Use a signal generator to provide a SMPTE color bars test pattern on the display to be adjusted.

2). While viewing the blue channel information only, adjust the tint control until the large internal bars blend with their patch below.

3). Perform Color Level and Color Phase tests until there is no additional color or tint control interaction and document the final onscreen values for color and tint.

i. Gray Scale:

1). Set the proper black level (bias) and gain settings for each of the three color channels independently using the “window” test patterns.

4. Cameras and camera equipment:

a. Adjust and set reference black.

b. Adjust and set white balance.

c. Adjust and set chroma level and phase.

d. Camera images shall be free of visible vibration.

e. Adjust and set pan/tilt limit switches.

f. Set camera presets in accordance with the design intent and Owner's requirements.

5. Timing: Properly calibrate video timing and genlock to ensure seamless switching and alignment.

6. Signal Processing Equipment:

a. Configure and adjust signal processing equipment to produce a properly aligned and centered image at the native resolution of the relative display for each potential source resolution.

7. Computer Interfaces:

a. Adjust gain.

b. Adjust peaking using H pattern.

c. Adjust horizontal and vertical position for the native resolution of the relative display.

8. System Calibration:

a. Properly calibrate individual system components. Verify signal continuity and quality throughout the signal path.

b. Document adjusted values of individual components.

c. Video images shall be free of anomalies, including, but not limited to, banding, bending, ghosting, reflections, video roll, visible jitter and double images.

E. Conferencing Equipment Setup and Testing:

1. Confirm connection to network interface devices and network services. Coordinate with network and/or service providers to resolve connectivity issues.

2. Program and document address information including, but not limited to, IP addresses, subnet masks, ISDN numbers, SPIDs and telephone numbers.

3. Program and document configuration settings including, but not limited to, bandwidth, transmission rates, QoS, video resolution, monitor configuration, audio protocol, multipoint settings and encryption.

4. Program and test camera positioning presets.

5. Conduct end-to-end test conferences both initiating and receiving the calls. Whenever possible test to facilities with which the Owner will typically be conferencing. Confirm communication including, but not limited to, the following criteria:

a. Clear visual images at the required resolution absent of signal degradation due to excessive network hits or packet loss.

b. Intelligible audio at comfortable volume levels free of feedback and echo.

c. Two-way operability of all auxiliary video and audio equipment including, but not limited to:

1). Audiovisual playback devices.

2). Computer interfaces.

3). Document cameras and visualizers.

4). Streaming media.

5). Recording devices.

6). Add-on audio conferencing.

d. If the conferencing system is connected to multiple network types, such as both IP and ISDN, testing shall be conducted on all connected networks.

e. If the conferencing system includes internal multipoint capabilities, multipoint test conferences shall be conducted connecting the maximum number of sites that the system is capable. Confirm all functionality as detailed in item 5.

f. If Owner will be utilizing a third-party bridging or gateway service, testing shall be conducted to and through the service provider.

F. Control Equipment Setup and Testing:

1. Test all hardwired and wireless network connections connected to the audiovisual system.

2. Verify proper operation of all equipment and devices connected to the audiovisual control system.

3. Verify correct function of all control system operations, including, but not limited to:

a. Equipment powers on and off correctly and in the proper order.

b. User is locked out of the system during system start-up and shutdown, timers are provided if this is an excessive period.

c. When system is "shutdown" all appropriate audio and video has stopped playing.

d. Gauges and feedback are registering correctly.

e. Automated functions are sequencing properly.

f. Interfaces are registering the same feedback.

g. Devices are being controlled using the most robust control method available

4. Verify installed GUI complies with approved design.

3.11 ACCEPTANCE TESTING

A. Before Acceptance Tests are scheduled, perform a system checkout. Furnish all required test equipment and perform all work necessary to determine and/or modify performance of the system to meet the requirements of this specification. This work shall include the following:

1. Submission of the test and measurement data.

2. Test all audio, video and related systems for compliance with the System Setup and Performance Verification as specified herein.

3. Check all control functions, from all controlling devices to all controlled devices, for proper operation.

4. Adjust, balance, and align all equipment for optimum quality and to meet the manufacturer's published specifications. Establish and mark normal settings for all level controls, and document these settings in the Operation and Maintenance Manual.

5. Unless otherwise specified, use tamper-proof security covers on all controls affecting overall system level balance and signal-to-noise ratio, such as power amplifier input level control, and input-output level controls for equalizers, mixers, amplifiers, etc. Some controls may require re-adjustment as the result of Acceptance Testing.

6. Maintain documentation of all performance tests for reference by the Owner's Representative during the System Acceptance Tests.

    a. Upon completion of the tests and necessary adjustments, submit a digital copy of a written report presenting test results, including numerical values of all measurements, for review by the Owner's Representative prior to demonstration and System Acceptance testing.

    b. With the above report, submit written certification that the installation conforms to specifications, is complete, and is ready for inspection and testing by the Owner's Representative.

7. Meet with the Owner and the Owner's Representative and make system changes as directed.

B. Upon completion of the Contractor's system checkout and performance verification, demonstrate the proper operation of all audiovisual systems in the project to the Owner's Representative.

C. Provide a qualified technician knowledgeable with the system and the installation to assist the Owner's Representative with the acceptance procedure.

D. The Contractor shall provide all labor, materials, tools, and measurement equipment necessary for these demonstrations, tests and adjustments.

E. System Acceptance Tests will not be performed until the Contractor's system checkout has been completed. The System Acceptance Tests will be supervised by the Owner's Representative and will consist of the following:

1. A physical inventory will be taken of all equipment on site.

2. The operation of all system equipment shall be demonstrated by the Contractor.

3. Both subjective and objective tests will be required to determine compliance with the specifications.

4. Acceptance Tests may include speech intelligibility surveys and subjective evaluations by observers listening at various positions under various operating conditions, using speech, music, and live or recorded effects material. Acceptance tests shall include viewing of monitor images for sharpness, contrast, brightness, and color.

5. Measurement of frequency response, distortion, noise, wave form, color vector, or other characteristics may be performed (or a demonstration test requested) by the Owner's Representative on any item, or group of items, deemed necessary to determine conformity with criteria.

6. All final Record Drawings, run sheets, manuals, and other required documents, as detailed herein, shall be on hand. Two complete sets of these documents shall be delivered to the Owner's Representative at this time. (One complete set shall have been delivered to the Owner's Representative prior to the scheduling of Acceptance Tests).

7. In the event further adjustment is required, or defective equipment must be repaired or replaced, tests may be suspended or continued at the option of the Owner's Representative.

    a. If the need for further adjustments becomes evident during the demonstration and testing, continue work until the installation operates properly. Included in the continued work shall include, but not be limited to, changes to or installation of resistive pads, readjustment of loudspeaker aiming, adjustment of system equalizers, programming changes to the control system, convergence of the video projector, if these adjustments are required.

    b. If acceptance of the system is delayed because of defective equipment or because the equipment does not fulfill this specification, reimburse the Owner for time and expenses for these tests during extensions of the acceptance-testing period.

3.12 DEMONSTRATION AND INSTRUCTION

A. Upon completion of the system installation and acceptance procedure, provide 8 hours of system training and orientation for the Owner's personnel. An individual intimately familiar with the equipment in the system and qualified to explain it in detail should conduct the training. When an employee capable of providing such training is not available, retain the services of someone qualified to do so at no additional fee.

B. Conduct the training prior to the owner using the system for the first time to ensure proper usage. If necessary, conduct the training at a time outside of normal business hours at no additional fee.

C. Shall include, but not be limited to:

1. Physical review of installed systems.

2. Review of systems documentation and test results.

3. Instructions on standard care and maintenance methods to enable Owner's personnel to successfully maintain system.

4. Additional Owner requirements defined during project.

3.13 CLEANUP AND REPAIR

A. Upon completion of the work, remove refuse and rubbish from and about the premises, and shall leave the relevant areas and equipment clean and in an operational state. Repair damage caused to the premises by the installation activities, at no cost to the Owner.

3.14 PROTECTION OF WORK

A. During the installation, and up to the date of final acceptance, protect finished and unfinished work against damage and loss. In the event of such damage or loss, replace or repair such work at no cost to the Owner.

SCHEDULE A – EQUIPMENT LIST

3.1 SMALL MEETING (TYP FOR 4 IN ADMIN)

Qty	Description	Make	Model
1	Lot of Cabling, Plates, and Panels	A/R	A/R
1	Lot of Mounting Hardware	A/R	A/R
1	Tabletop Interface	Crestron	CCS-UC-1
1	UC Engine	Crestron	UC-ENGINE-S-Z
1	USB/HDMI Converter	Crestron	HD-CONV-USB-200
1	PTZ Camera	Crestron	UC-CAM-HD-520
1	Flat Panel Display, 55"	NEC	V554Q

3.2 MEDIUM MEETING (TYP FOR 2 IN ADMIN AND 1 IN CFM)

Qty	Description	Make	Model
1	Lot of Cabling, Plates, and Panels	A/R	A/R
1	Lot of Mounting Hardware	A/R	A/R
1	Tabletop Interface	Crestron	CCS-UC-1
1	UC Engine	Crestron	UC-ENGINE-S-Z
1	USB/HDMI Converter	Crestron	HD-CONV-USB-200
1	PTZ Camera	Crestron	UC-CAM-HD-520
1	Flat Panel Display, 65"	NEC	V654Q
1	Extension Mic	Crestron	CCS-UCA-MIC

3.3 LOUNGE/LARGE MEETING (TYP FOR 1 IN ADMIN)

Qty	Description	Make	Model
1	Lot of Cabling, Plates, and Panels	A/R	A/R
1	Lot of Mounting Hardware	A/R	A/R
1	AV Equipment Rack	A/R	A/R
2	Input Tx	Crestron	DM-TX-4KZ-100-C-1G-W-T
1	Presentation System	Crestron	DMPS3-4K-350-C
2	Display Rx	Crestron	DM-RMC-4KZ-SCALER-C
2	Flat Panel Display, 98"	NEC	V98Q
2	PTZ Camera and Bridge	Vaddio	RoboSHOT 30E HDBT OneLINK Bridge System
2	UC Engine	Crestron	UC-ENGINE-S-Z
6	Boundary Mic Tx	Shure	MXW6/O
2	Handheld Mic Tx	Shure	MXW2/Beta58
1	Mic Charging Station	Shure	MXWNCS8
1	Access Point Tx/Rx	Shure	MXWAPT8
1	Wireless Mic Interface	Shure	MXWANI8
1	Audio DSP	QSC	Core110f
1	Audio Amp	QSC	SPA4-60
22	Pendant Loudspeaker	QSC	AD-P6T
2	Control Panel	Crestron	TSW-1060

End of Section

SECTION 280000
SECURITY SYSTEMS

PART 1 GENERAL

1.1 SYSTEM DESCRIPTION

A. The Storm King Art Center recently engaged a consultant to prepare a master plan for replacing existing alarm, access control and CCTV systems in use, with systems that will meet the needs of the institution into the future and during subsequent construction phases. The systems specified have been specified for a reason, and existing systems will not be used or expanded, and substitutions for systems specified will not be entertained although some substitutions for specific equipment may be invited in certain limited situations in this specification.

B. Requirements of this section include furnishing all labor, permits and materials and performing all work for installation of DSC brand Power Series PC1864 Commercial Integrated Security Systems, as necessary to perform as described for burglar alarm coverage in multiple buildings being built in this phase as shown on the plans. Note that this work will occur in phases. The documents break out the work, and plan notes and deltas and bubbles on the plans define what is being bid in this first phase. The narrative description of work explains the entire project so you understand the full project in multiple phases and the plans and schedules explain what work is in Phase 1 and what is in a future phase. See the plans and schedules for the exact work being purchased in this first phase. As a general statement, work in Phase 1 includes work on exterior cameras at or near ticketing shown on the plans, alarm, access control and CCTV in the Welcome Center, alarm, access control and CCTV in the ticketing area, alarm, access control and CCTV in the restroom area, alarm, access control and CCTV in the CFM Building, and some work locating client terminals in an existing building to function as a temporary command center until phase 2 buildings are built..

It also includes providing and installing a Kantech EntraPass access control system integrated with the DSC Power Series PC1864 alarm system to provide access control as defined in these plans and specifications in multiple buildings. The Kantech Entrapass system software shall be the Commercial Edition provided as part of the Intevo Advanced Intuitive All-in-One Platform, model Intevo ADV-4TB with 4 TB storage and 4 IP camera licenses, an ExacqVision NVR model IP04-12T-Q with 12 TB of storage and 4 IP camera licenses is also specified herein.

It also includes providing twelve (12) additional camera site licenses for the ExacqVision IP04-12T-Q NVR so that this NVR has a total of twenty (20) IP camera licenses. Further, it includes the rack mount kit for the NVR, a USB keyboard, and a USB mouse. Also provide an Intevo Advanced Gen 2 three-year software support agreement.

It also includes providing and installing the client terminals as shown on the plans and device schedules for the alarm, access control and the CCTV systems. Note that when the administrative building is built in a future phase, that building will house the above front-end equipment. But until that administrative building is built, this equipment will be housed as shown on the plans

It also includes providing and installing an Illustra CCTV system by American Dynamics with video management software as included in the Intevo Advanced system package and the NVR specified above.

Provide and install the client CCTV terminal and the 24” terminal monitor and other hardware and software as shown on the plans and schedules as being part of phase 1.

A future phase includes moving and installing equipment purchased in phase one substantially as shown on these plan detail drawings for a command center in the Administrative building where the

alarm, access control and CCTV equipment shown on the plans and device schedules will be housed. While this is not being purchased in this phase, we disclose this at this time so you understand the full extent of the systems when fully built out.

The DSC Power Series PC1864 v4.5 burglar alarm system defines a technology of system that allows the use of detectors with point interface devices integral to allow a number of detectors to be used on a single circuit and still have a distinctive point address, or to use detectors of virtually any type, without integral point interface devices, but where separate point interface devices are used on the circuit for the purpose of providing the distinctive point address. In addition, This burglar alarm system integrates fully with the access control system and CCTV systems via the Intevo Advanced package and added camera capacity and data storage is achieved via an add on NVR..

The Kantech access control system is a cost-effective access control solution that integrates fully with the DSC Power Series PC1864 alarm system through a PC-based front end, and enables an operator to view alarms and access control system activity from multiple buildings on a client terminal. While physical keypads are used in the field for the alarm system, virtual keypads appear on the client terminal that enable the operator in the command center to arm and disarm points and zones.

The Illustra CCTV system uses infrared low light level cameras. The Intevo Advanced server includes CCTV system software with 4TB data storage and the ability to accommodate 16 IP Cameras per unit. Further, the Intevo Advanced system as designed includes one additional ExacqVision Q series IP NVR which the contractor shall provide and install with 12 TB of data storage and pre-loaded VMS software.

The PowerSeries control panels include future wireless capabilities for the burglar alarm system for a future, still undefined exhibit alarm system to be specified as part of a future construction phase but for this phase, all alarm devices are hardwired.

C. The system includes identical DSC Power Series PC1864 control panels in the quantity required to perform as specified in the buildings shown on the plans, as well as required accessories including PTK5507 keypads, motion detectors, concealed door contacts, panic buttons, local annunciators, point interface devices to give each device a unique point address and other alarm initiating and alarm indicating devices as shown on the plans and listed in the device schedules and equipment lists, as well as other incidental equipment and services. Equip each control panel with network cards or other required accessories to get the signals onto the assigned fiber optic security network.

D. Also included is the installation of all required alarm system, access control system and CCTV system wire and cable within buildings and to exterior cameras. Others than the security contractor will provide a dedicated computer network for the security system. The dedicated security network will run between buildings and will terminate at a point within each building. Network termination points are shown on the plans and details.

E. Work includes providing and installing all card readers, request to exit devices, electric locks or strikes specified for reader-controlled doors and all other electronic hardware and their components to work with the readers as well as readers, request to exit devices and software in buildings shown as being constructed in Phase 1. Additional card readers are provided that are used for arming and disarming the alarm system by double tapping a valid card on the reader.

F. Further, the project involves providing and installing all security system wires, in conduit that is being provided under other sections of this specification for use by the security contractor, and providing and installing all point interface modules, detectors, contacts, end of line resistors, and other devices in this phase. Conduits are required from devices to the alarm control panel.

G. End of the line resistors shall be used for each alarm circuit and shall be located at the detector end of the line and not at the alarm control panel.

H. All alarm and access control system and all CCTV system wires run ultimately to the room(s) indicated in the drawings. CCTV wires shall be CAT-6 and power for cameras shall be a Power over Ethernet scheme. Cameras are digital IP cameras which receive their digital address internally. Note that not every camera will work with the Intevo Advanced system so use the specified camera.

I. A client PC will be provided and installed to cause alarm and access control images to be displayed on the client terminal monitor in matrix format. The monitor shall be a 24" LCD model with high resolution. Provide and install the client alarm and access control system client terminal. Make and model is shown on the device schedule.

J. A client PC will be provided and installed to cause CCTV images to be displayed on the client terminal monitor in matrix format. The monitor shall be a 24" LCD model with high resolution. Provide and install the client CCTV terminal. Make and model is shown on the device schedule.

K. In a future phase, you will provide and install in the security command center one "driver PC" to cause the images generated by the CCTV cameras to be displayed on the large format monitor also installed in a future phase. Provide and install the large format monitor with an appropriately sized wall monitor mounting kit.

L. DSC Power Series PC 1864 control panels are located in each protected building at locations shown on the plans, and annunciate on keypads located in the building at the locations shown. They also annunciate on virtual keypads on a alarm and access control system client terminal in the command center

M. The plans and zoning charts clearly define grouping of detectors into shunt groups or control panel partitions which must be used. The installation of this system exactly as specified with regard to shunt groups is mandatory. From time to time throughout the project changes may be ordered which modify, add to or change the use of partitions and re-assign groups, All changes will be approved by the security consultant and will be documented on revised shop drawings before the work may begin. To avoid confusion resulting from possible changes the preparation of modifications to the shop drawings is essential, particularly with regard to the use of partitions and alarm grouping. Where spare partitions are unused in our design, they shall remain unused for future use unless their use is authorized by the security consultant.

N. Also included in the project is a requirement that the alarm signals be sent off site to a UL listed central monitoring station by a method that meets or exceeds UL Grade "C".

O. Provide and install all security hardware shown on the drawings and listed in the Schedules including electric strikes or locks, strike or lock release buttons, electric strike or lock power supplies or transformers, etc.as being part of Phase 1.

P. Monitoring within the buildings will eventually, after both phase one and phase two are complete, occur primarily at the main security command center but activity within a building will annunciate on the building's keypad(s).At the end of Phase one alarm and CCTV monitoring will occur on the client terminals being purchased in Phase 1 and will occur in the location of those terminals as shown on the plans.

Q. Provide and install additional client terminals on the dedicated security network for the CCTV and the access control system at the locations shown on the plans.

R. Provide and install high resolution IP CCTV cameras of the make and model specified on the device schedules reporting to and recorded on the NVR. In the future, they will also be displayed on the several client terminals and on the large format monitor in the future phase 2 command center. The quantity of cameras in the total system is as shown on the plans and device schedules. Fixed cameras have varifocal lenses unless otherwise noted on the Schedule. Some cameras have weather resistant

enclosures, and environmental kits as shown on the Schedule. Some cameras are mounted on buildings.

S. All specified cameras shall record on the NVR assigned. The camera capabilities of the Intevo Advanced unit shall be retained for future use only and shall not be used for cameras due to limited storage.

T. Provide keypads at various locations shown on the drawings throughout the Phase 1 buildings. Keypad's arm and disarm groups of detectors on that panel and annunciate alarms. Detectors are numbered to show the shunt groups they are assigned to, but devices still are to annunciate point by point. Preserve this shunting plan. Virtual keypads appear on the Kantech client terminal.

U. The specified control panels shall each have eight partitions enabling any keypad on that panel to arm or disarm any partition on that panel. Some partitions may be unused in the grouping specified on the device schedules and thus are to be kept unused as spares for future use. Do not re-assign partitions or waste future space capacity. Do not protect multiple buildings on one alarm control panel. Each building shall have its own panel.

V. The plans and details show electrical power outlets to be provided in Phase 1 buildings under other sections of this specification for use by the security contractor in powering panels and other equipment. If you require additional power outlets in phase 1, include the cost of these in your bid. Locations where outlets are to be provided by the electrical contractor for use of the security contractor are at the alarm and access control panel locations and locations shown on the plan details, if any.

W. Provide and install an access control system defined herein. A valid card presented to a door reader causes the electronic lock to release and the contact to shunt momentarily to allow passage through the door. The security contractor will coordinate to assure that the electronic hardware functions with the system. A valid card presented (double tap) on a reader designated for alarm system arming and disarming, causes the alarm to arm or disarm.

X. Concealed magnetic door contacts on doors with card readers and an alarm point use double pole double throw (DPDT) door contacts with one side of the contacts for the access control system and one side for the alarm system.

Y. Substitutions are not permitted unless specifically invited in the specification, and substitutions accepted for one building must be used in all buildings. This is part of a master plan for multiple buildings on this site and will be expanded to other buildings in a future phase. The engineer who designed the security system is aware that there are alternate products available. He has made an informed decision to specify the wiring scheme and product choices in this specification. Contractors shall not offer alternate products or methods.

Z. The designer has attempted to select detectors with built in point interface modules that give the detector a point address but where this is not possible or was not done, external point interface devices are to be used and mounted concealed at the detector.

AA. Provide UPSs at client terminals, NVRs, servers and driver PCs that allow an orderly shutdown of the computers. Provide four hours of battery backup on each alarm control panel.

BB. Provide and install an access control system card reader of the make and model shown on the Device Schedule for opening and closing the gate (gate by others).

CC. One or more sheets of the drawings comprise Device and Equipment Schedules. These Schedules are numbered to correspond to the device numbers on the plans. The Schedules indicates the make and model for each major component in the system building-by-building. Not every component or software is shown on the schedule. Minor accessories and components may have been omitted but are still

required. The Schedules are not intended to comprise a complete parts list. The plans show buildings included in Phase 1 and buildings in a future phase. You are bidding on PHASE 1 only.

DD. Operational Summary:

All buildings will function substantially alike. The first employee arrives in the morning at a building's reader-controlled entrance and double taps his or her access card on the assigned reader and the alarms turn off. Presentation of a valid card at the reader also releases the door lock and allows access. Where the arming and disarming reader is located inside the building, they shall use their card to unlock the entry door. They shall open the door causing an entry exit delay to initiate. They shall enter and double tap the disarming reader to disarm the alarm system. When the main alarm terminal P:C is occupied by a guard or staff member, they may phone or radio the guard of staff member and have him disarm the alarms system using his virtual keypad.

Alarms that occur in this building are annunciated on the keypad(s) as well as over the dedicated security network at the main alarm client terminal and are transmitted off site to a UL listed central station via the phone line.

All security devices in the building except card readers are assigned to a shunt group. Shunt groups represent a partition on the panel. Keypads and card readers are mounted at a uniform ADA compliant height for accessibility and are used for annunciation as well as arming and disarming of alarms.

Request to exit devices of the make and model specified on the Schedules are to be provided and installed as part of this work.

During the day few alarms are active but those alarms that remain on can be monitored on any keypad in that building and are not routinely transmitted to the central station except that alarm inputs such as panic alarms are transmitted at all times to the central station. During the day, when some partitions are shunted, others, such as those on fire exit doors and the collection storage vault, can remain alarmed. Opening of one of these doors will cause an alarm to be created and the local audible alarm to trip. Programming of these alarms is by the security contractor.

In a future phase, at the archive collection storage room in the future Administrative Building, the user uses his access card to release the electric lock and momentarily shunt the contact on the door to enter. Upon leaving, he activates the request to exit device and the contact on the door again shunts and the lock releases. When the door closes again, the alarm contact is re-armed and the lock re-locks.

High resolution CCTV cameras using Power over Ethernet power scheme and CAT-6 network cabling, display on a 19-inch LCD high resolution color monitor in matrix format on each client terminal. Multiple screen layouts may be required to display all cameras in other configurations. The images are recorded on an NVR and images are retained for a minimum of 30 days.

At the end of each day a guard or employee conducts a patrol to identify stay behinds and other problems and secure the building, assuring that all points "set-up". The last employee out of a building uses his programmed access card to arm the building by tapping the card reader. This activates the alarms or initiates a programmed entry exit delay as required.

At the alarm and CCTV system client terminals, the operator monitors building alarms and cameras on client terminals. In Phase two, the client terminals will be moved to the new administrative building's security command center where a second client terminal running client software and mounted in a rack, drives the image on the large format monitor that is wall mounted and purchased in Phase 2. All camera images display in large format on this monitor but additional configurations can be programmed for this monitor.

When an employee is unable to alarm and arm a building, it can be done by the guard at the alarm client terminal using virtual keypads on his alarm and access control system client terminal.

Servers are rack mounted in the locations indicated on the plans..

Client terminals for the alarm/access system and the CCTV system are located in certain offices so that the administrators can issue and program access cards and adjust CCTV specifications. See the plans.

1.2 SUBMITTALS

A. AFTER AWARD OF BID

1. Specification sheets (cut sheets) of all proposed equipment shall be provided digitally for review by the architect and security consultant's. This includes products for which no substitution was requested. Each major component in the system is to be included. Where more than one product is shown on a sheet, indicate which product is being provided by producing an arrow or other identifier pointing to the device to be supplied. Specification sheets may be provided digitally in .pdf format.

2. Equipment list identifying only equipment being purchased in Phase 1:

a. Model number of each unit
b. Quantities of each type of device
c. Unit cost of each device if purchased separately as a change
d. Spare parts list. Break out from your list of device quantities how many are for immediate use and how many are for spare parts as specified.
    a. It should be possible for the reviewer to review the list and know that the security contractor has not made substitutions and that he as properly designed the system he will be providing.

Where each building is bid separately on the Bid Form, submit a separate Equipment List for each building. May be submitted digitally but must be signed by the sub-contractor authorized representative.
Please use Attachment "A" or an alternate form that provides all of the requested wording.

3. Specification compliance statement: a letter submitted digitally with the bid responding to specification sub-sections individually, indicating exceptions, substitutions, and alternates. If there is no variation, say so in the letter. There shall be no exceptions taken or substitutions listed that have not already been approved by the security consultant. May be submitted digitally but must be signed Please use Attachment "B" or an alternate form that provides all of the requested wording.

4. Shop Drawings shall provide plans and details of the proposed system architecture in Phase 1 and the work to be performed. Include point-to-point drawings of systems and individual device wiring diagrams, details of all power and power supplies, a CCTV system block diagram, and alarm and CCTV system riser diagram, and an access control system riser and block diagram. Submit shop drawings and completed Attachment "C" digitally. Submittals shall be as a complete set; partial submittals may not be accepted. Drawings shall identify symbols used and shall be dated.

a. Show power requirements, battery back-up to be provided based on calculations, end of line resistors, wire type and size and numbers of conductors in each conduit, and similar details.

The contractor is advised that the intent of this section is to clearly convey to the owner's technical representatives and the museum's insurance inspector that the installation firm has thoroughly thought out the installation and efficiently and properly engineered the system. The definition of a "shop drawing" is a set of drawings prepared by the engineer in the office that instructs the installer in the field exactly how the work is to be performed. Your shop drawings shall meet the spirit and intent of this definition. You're as-built or record drawings are to use the shop drawings previously prepared and include field notes taken on a daily basis by

the installer showing modifications made to the design as a result of authorized changes, field conditions, etc. During construction management visits the owner's technical representative will expect to see a set of approved shop drawings on the site and in use and they must show the daily mark-up changes and field notes. Without these real time notes it is the opinion of the owner's technical representative that accurate as-built drawings will be impossible to prepare from memory.

Hardware, equipment, and methods used for seismic stabilization as referenced elsewhere in this section shall be detailed for approval by the security consultant on the shop drawings.

B. UPON COMPLETION OF SYSTEM INSTALLATION

1. "As-builts": 30" x 42" format digital drawings for review and approval by Security Consultant, of each floor plan and the site plan indicating exact device locations, detail drawings, riser diagrams, block diagrams, panel terminations, cable routes and wire numbers as tagged and color-coded on the cable tag. Show end of line resistors and point interface modules that give devices a point address and final point-to-point wiring diagrams documenting formally the alarm shunt grouping of each panel, detection and annunciation device and keypad. Show conduit fill including type of wire or cable, quantity of each type in a conduit, and other details. Show power and cable details.

2. Provide all drawings digitally in AutoCAD on DVDs in the format and quantity of the shop drawing submittal. Due to insurance requirements the project shall not be deemed to have been successfully completed until the security consultant signs off on as-builts and other specified tests are completed. Similarly, the warranty will not begin until the security consultant signs off on the system including approval of as built drawings.

3. Operation and maintenance manuals: manufacturer's operation manuals explaining the operation and maintenance of the system(s). Provide one set on paper and one set digitally in .PDF format.

4. Keys to enclosures to the owner's technical representative and a receipt for these keys with your submittal as evidence of completion.

5. A letter certifying completion. This letter shall be completed and submitted ONLY after successful completion of the final acceptance test, completion of the punch listed items in their entirety and certification that they have been completed, and receipt of the approval of the as-built drawings and other submittals, from the consultant, and completion of employee training. Indicate that based upon the above that the work is finished in its entirety without additional punch listed items remaining to be completed. Indicate the date that the latest of the above was completed. Submittal of this letter certifying completion of the project prematurely will result in significant delays in final approval and may require a site visit by the consultant to verify. Since the certification of final completion signifies the beginning of a warranty period with dollar value paid by the owner to the contractor as part of his fee for performing this work, pre-mature submittal of certification of completion when completion has not occurred is an unacceptable business practice at best and a fraud at worst. Do not pre-maturely submit this document as doing so may result in legal action that delays the commencement of the warranty for a long period of time at the expense of the contractor. This letter will document the date that the warranty begins and thus when it expires and when accepted by the owner becomes a legal document that is part of the agreement. Warranty does not begin with "substantial completion" to each building.

1. CONSULTANT ASSISTANCE WITH SUBMITTALS
   a. Prior to beginning work on submittals, contact the Security Consultant through the architect and request instructional material that will assist you in preparing the required submittals to assure satisfaction of insurance requirements. Or, you can download a sample set of acceptable shop drawings that will serve as your general guide of what is expected by visiting http://www.stevekeller.com/SteveKellerandAssociates/Contractor_Support.html
   b. Download a document called Welcome Contractor from a link on the page above which requires you to submit certain information to him through the architect such as the names of your key contact personnel in the office and on site and security data required by fine arts insurers.

Failure to submit required information will likely result in payment delays. Note that this is very important information that we must have for insurance purposes and at some point in the process, if we do not have it in file, you could be required to stop work and forfeit payments due. Please submit this material requested as early in the process as practical to avoid problems.

c. The “Welcome Contractor” packet requires that the security sub-contractor assure that his installers in the field have read the spec or had it explained to them in detail and have a copy available for reference throughout the installation process, If at any time the installers do not have access to or have not been read the spec in detail or do not have approved shop drawings on hand to facilitate the work, work will stop and a penalty, sometimes high, may be imposed.

2. Consultant will perform a very detailed check of the shop drawings and as built drawings. They will trace every circuit and account for all points, their proper zoning and assignment to shunt groups, wires, quantity of wires and other details. Do not submit partial submittals. The Consultant cannot do a review in detail without all submittals in hand. Be sure that your point address numbers coincide with the point address numbers on the bid drawings as these enable everyone to visually see the shunt groups and panel assignments. Insurance inspectors will ask to see the documents and compare them to actual installation. DO NOT UNDER ESTIMATE THE IMPORTANCE OF COMPLYING WITH THIS SUBMITTAL PROCESS DUE TO THE INSURANCE REQUIREMENTS AND FUTURE INVOLVEMENT OF THEIR INSPECTORS. Unlike many commercial alarm system projects, this requirement is especially stringent for a museum environment,

3. Security Consultant will perform up to two reviews of each submittal. The first will be accepted or returned as inadequate or with corrections requested. The second will also be accepted or returned as inadequate. Any subsequent reviews will be at additional cost to the Contractor at the consultant’s hourly rate plus expenses. Please note that it is not the security consultant’s responsibility to check your work. Please check your work for accuracy before submitting. The security consultant and architect reserve the right to stop any submittal review if deemed inadequate and not complete the review until quality is assured.

1.3. QUALITY ASSURANCE

A. SECURITY SYSTEMS INSTALLER

1. Security system installer: Shall maintain all licenses required by local, county or state licensing authorities, shall be an authorized dealer of the product being provided and installed, and shall have completed other projects of this complexity with the specified product. Electrical contractors not qualified to install low voltage security systems may not be used by the General Contractor to perform this work except under the direct supervision of a factory authorized installer for the product being installed. This includes pulling of wires but does not include installation of conduits and high voltage power for the system power supplies. We are not requiring a UL installation certificate and thus we cannot waive this requirement for low voltage installation expertise involving the system specified as it reduces integrity of the system below what will be accepted by fine arts insurers.

2. No fewer than two weeks before beginning work on the premises, provide the security consultant, through the Architect, with a list of names, addresses, dates of birth, and history of employment with the Contractor or sub-Contractor for each security system installer or helper on the job. Include any occupational license information in this submittal. Each employee who will work on the system both in the Owner's facility and prior to its delivery such as but not limited to the design stage, and any person with access to drawings, specifications, and proprietary information regarding the system shall agree in writing to submit to a background check by the Owner or his agents including a criminal history check. The Owner may for any reason exclude any employee of the Contractor or Sub-contractors from working on this project. Acceptance of this project authorizes the owner or his agents to conduct a background check to whatever extent they deem appropriate on any of Contractor’s employees or sub-contractors working on the security systems.

3. Security contractors:

a. Must have successfully completed no fewer than five (5) previous projects involving complex installations of the product being installed or similar products and systems.

B. STANDARDS

1. All components must be UL listed for their use.

2. All work and equipment shall be manufactured, tested, and installed in accordance with standards and suggested guidelines which are applicable unless the specific standard is waived in part by the Owner on a case by case basis:

a. Underwriters' Laboratories, Inc. (UL)
b. Commercial Burglary Central Station B
c. Commercial Burglary and Fire-Local
d. Commercial Burglary and Fire--Central Station
e. UL Standard 287, "Standard Line Security" dated October 1996 or later
f. National Fire Protection Association (NFPA) 101, "The Life Safety Code"
g. Local Prevailing Codes

1). Where local and/or state codes differ from the above, such codes shall govern in all cases. Where the above standards exceed code and compliance with the more rigid standard is acceptable to local and state authorities, the more rigid standard shall apply. No other variance is authorized without written authorization of the Architect.

D. ACCEPTANCE TEST

1. Upon completion of the installation, a complete performance test of each device, switch, control unit, power supply, battery stand-by unit, each monitor panel, controller, printer, camera, monitor and all other equipment and material required by the contract shall be conducted in the presence of the Owner and Consultant or their representative(s). This is an involved test often taking one or more days and all deficiencies will be required to be corrected promptly. Contractor will have a minimum of two technicians present for the entire test.

2. Items to be tested include:

a. The transmission of the signal to the central station with the phone line and again with the cellular back-up dialer.

b Show that the complete system is free from grounding or open circuits.

c. Demonstrate that each alarm initiating device functions as specified and produces the specified alarm actions. Each motion detector shall be aimed by the Contractor and tuned to provide coverage of the protected area in accordance with the capabilities of the device. This is an active test of each device and cannot be accomplished by placing the panel in walk test mode and activating all devices then comparing the results with the print out. Each device will be tested to see if:

1. it is properly aimed to cover the area required.
2. it is properly installed and has no electrical or cosmetic problems
3. its walk test light functions. Do not turn off walk test lights.
4. its sensitivity is adequate and it covers the optimum and maximum area
5. it activates promptly and does not require multiple hits before activating
6. it reads out on the keypad and print outs and at the central station properly

7. It is properly depicted on the as built drawings and the point and group number and descriptor match the drawings and riser diagrams.
8. It outputs to the specified output and properly performs the intended output function as specified.
9. The card access function works as advertised.

d. An abnormal condition of any circuit or device required to be electrically supervised will result in activating the specified trouble or tamper alarm signal.

e. Show that the emergency power source is capable of operating the system for a full 4 hours after failure of the generator.

f. Show that alarm signals are audible at the monitor point by point.

g. Show that the system is operable under the specified trouble conditions.

h. The software functions properly as specified and the equipment is properly programmed. The Contractor shall be responsible for programming the systems so that English language descriptors specified by the Owner "read out" and print out and so that all devices function as requested on the schedules, i.e., entry exit delays and independent zone controlling. Typical descriptors are “Motion Room XXX” or “Door Main Lobby”, etc. The access control system shall be fully programmed with full English language descriptors and a floor plan graphic. Access card data and the photo of the employee who is assigned the card shall appear when a valid card is presented. The DSC/Kantech interface properly imports and displays each alarm point and they display in text and graphically on the maps. The CCTV system is programmed with easy to understand descriptors and instructions including time date and location.

j. The system as installed matches the record "as-installed" drawings according to a spot check by the Consultant. Alarm shunt grouping will be verified. Power supply adequacy will be verified. Spare capacity will be verified.

k. Good wire management practices must be used and wires must be neat in enclosures and properly trimmed to avoid excess wires within enclosures.

2. Acceptance by the Owner will be given after completion of the installation in all details, satisfactory completion of the system reliability tests, and receipt by the Owner of all required drawings and documents. A letter certifying that the installation is complete and fully operable shall be forwarded to the Consultant by the Contractor. The letter shall include the names and titles of all witnesses of the tests.
3. Prior to the test, set all detectors on maximum sensitivity, minimum pulse count unless conditions absolutely necessitate making detectors less sensitive to avoid false alarms.
4. At the conclusion of the project the Contractor shall carefully prepare for the final acceptance test. Prior to calling for the test, the Contractor will pre-test and issue a written report to the security consultant of the results of the test. The security consultant will travel to the site for as many days as are required to perform the test. If, upon conducting the acceptance test, the security consultant and the architect both agree that the system is not complete beyond a reasonable punch list of incomplete items which can be retested by the architect or owner’s representatives, a retest will be scheduled and the test conducted at the expense of the alarm Contractor at the fee and terms of the contract between the security consultant and the owner.
5. Any fees and expenses due the security consultant for submittal re-reviews or re-testing may be withheld from the retainer due the Contractor. The consultant’s fees for all of these extra services are at the hourly rate agreed to by the Architect in his contract with the Consultant plus actual expenses. Travel time to the site is billable at the hourly rate. A successful acceptance test is required for fine arts insurance and will not be waived. As it is not likely that the fees and expenses for a re-test of the system will be less than $6,000 the contractor is urged to pre-test the system using the strict requirements

above and call for the acceptance test only when he is certain that the system complete, fully operable and trouble free.

E. TRAINING

1. Submit to the security consultant the outline and content for a four-hour training program for facility staff on the operation, maintenance and programming of the equipment included in this project and a one-hour program for rank-and-file employees on daily use of the system. Training for attendees at the four-hour session includes the alarm, access control and CCTV systems. Training for attendees at the one-hour session will learn about the alarms and use of the card readers. When the security consultant has approved of the quality and content of the training, provide one formally scheduled four-hour training session to the owner's employees as designated by the owner. The one-hour program for staff shall follow and shall include information normally needed by staff to use the keypad and reader functions of the system, arm and disarm alarm groups, bypass points that are problematic, transmit a duress alarm, and interact with the central stations. Explain the theory of operation of the systems, their reporting to the central stations, and related aspects normally required for users for a trouble-free operation. Time spent informally instructing owner's personnel on operation of the system does not count as training. Training counts only when it is formal, scheduled, and documented and held at a mutually approved time and only after the program has been approved by the consultant. Retraining will be provided if necessary if the Contractor proceeds with training without first obtaining approvals. The security consultant may attend the training so a mutually agreed upon time must be established in advance.

a. Submit the outline in MS Word format to the consultant for review at least 30 days prior to scheduling of training.

F. SECURITY CONSULTANT

1. The security consultant is Steve Keller and Associates, Inc., Inc. 555 Granada Blvd. Suite G-4 Ormond Beach, Florida 32174 (386) 673-5034; Email steve@stevekeller.com.

2. Immediately upon being awarded the contract to provide and install the alarm and CCTV systems (but not before) the security sub-Contractor involved shall be instructed to notify the security consultant by phone or email and advise him of his involvement in the project. The consultant will provide to the Contractor AutoCad disks containing the bid drawings, which will facilitate the Contractor’s preparation of shop drawings and as-built drawings.

1.4 WARRANTY

A. ALL SECURITY SYSTEM COMPONENTS AND WORKMANSHIP

1. The systems shall be guaranteed against all defective materials, design and workmanship for a period of one year from the date of acceptance. New replacement parts shall be furnished promptly and defects in design and workmanship shall be corrected, without cost to the Owner, promptly upon receipt of notice from the Owner of failure of any part of the system during the guarantee period. When the manufacturer's warranty period exceeds the one-year warranty, the longer period will be in effect. Equipment shall not be warranted against damage by acts of God or misuse but shall be warranted for normal use as intended.

2. Any item failing and reported as needing service more than one time before the one-year guarantee period expires shall be replaced and the guarantee extended for twelve months from the replacement date of the item. There will be no cost whatsoever for labor or materials.

3. One-year full parts and labor warranty shall commence upon final acceptance by the security consultant (See acceptance testing criteria) and NOT upon substantial completion of the work, or use by owner.

4. No other warranty terms or modifications will be permitted. Submission of a bid implies acceptance of these warranty terms without qualification or exception.

B. CCTV SYSTEM WARRANTY

1. Cameras shall be warranted for the term of the warranty provided by the manufacturer. If no warranty is provided by the manufacturer, a minimum of one year warranty shall be provided by the security sub-contractor.
2. All other components shall be delivered with the one-year full parts and labor warranty. This includes all CCTV servers, CCTV client terminals, driver PCs, and related Dell components.

1.5 RELATED SECTIONS

A. Electrical
B. Door and Hardware
C. Computer Networks
D. Vehicle gates

PART 2 PRODUCTS

2.1 COMPONENTS

A. BURGLAR ALARM SYSTEM

1. Alarm control panel: DSC Power Series PC 1864 Commercial Integrated Security, with four hours of battery back-up and network access control card installed. No substitutions.

2. Keypads: Full Message LCD Hardwired Security Keypad PTK5507 keypad. No substitutions.

3. Point interface devices: As provided by DSC for use with this panel.

4. Alarm indicating and annunciating devices: as indicated on the device schedules.

5. Wire and cable: Belden, or equal, as required by DSC for length of run required. Wire types as well as the quantity of wires in each conduit will be shown on the shop drawings and approved by the security consultant prior to commencement of work.

6. No security system conduit shall be smaller than 3/4 inch diameter. While conduit is being provided for your use by the electrical contractor, should you provide conduit extensions at any location, observe this minimum size.

B. CLOSED CIRCUIT TELEVISION SYSTEM

1. The CCTV system consists of cameras, camera mounts, enclosures, poles, heaters and blowers where specified, PoE switches, cabling from the switch to the camera, NVRs, client terminals, UPSs, monitors, monitor mounts, driver PC as defined in the spec, the Intevo Advanced server, software, and other components. Components shall be of the make and model indicated on the plans, schedules and spec.

2. Cabling shall be CAT-6. Power shall be provided over the Ethernet cable serving the camera. Only one camera may be placed on any CAT-6 cable run to the switch where the circuit connects to the network provided by others. Cabling to the PoE switch and connection to the network is to be provided and installed as part of the security contractor's work. The network into the building and the PoE switch is provided by others than the security contractor.

3. Cameras shall be of the make and model specified in the device schedule. Do not make substitutions.

4. Provide all servers, monitors, drives, cabling from the camera to the PoE switch, POE switches, cameras, camera power supplies, UPSs, NVRs, and other network and CCTV components shown or required to perform as required. Provide monitors as shown in the plans and details for the command center. Provide all programming. Provide all labor and licenses.

.

C. CARD ACCESS SYSTEM

1. Provide and install a Kantech EntraPass Corporate Edition access control system including all servers, access control controllers, readers, electric locks, request to exit devices, power supplies, client terminals and other components. NOTE: This is phase one of a master plan. Do not provide software with lesser capacities assuming that we purchased the wrong version. Our intent is to buy software with adequate capacity for the future as part of this purchase.

2. Card readers shall be of the make and model indicated in the device schedule. No substitutions without pre-approval. Reader controllers shall be of the make and model indicated on the access control system.

3. Provide 500 boxed proximity access cards. The owner has an existing card printer. Install the existing printer on the system and program so the owner can print employee ID cards integrated with the proximity access cards. Cards are to be essentially ready for user printing. The owner has artwork for their cards. All access cards are to be input or introduced into the system and ready to be activated by the owner when assigned to an employee.

4. Proximity card readers and request to exit devices and electric door locks are to be the make and model indicated on the device schedules mounted at an ADA accessible height in the locations shown on the drawings.

D. EQUIPMENT HOUSINGS AND ENCLOSURES

1. Control communicators, power supplies, and other components of the control equipment are to be installed in appropriate metal tamper protected, locking enclosures or cabinets and shall be tamper protected.

2. Enclosures for panels, power supplies, cabinets, alarm devices, and detection equipment, and other system components supplied by the Contractor, if other than that specified, shall be so formed and assembled as to have ample strength and rigidity necessary to resist the abuses to which they are likely to be subjected. They shall be constructed of sheet metal, and shall be not less than No. 16 U.S. Standard Gauge. Access doors shall have locks keyed alike. Provide eight keys.

3. All enclosure locks shall be of the type utilizing a flat key manufactured by a manufacturer of high security locks. No enclosure key shall be left unattended in panels during the installation phase. Exercise every precaution to protect the integrity of the keys. Upon completion of the work, all keys shall be delivered to the owner's visitor services and security representative properly tagged, and a receipt for delivery will be obtained that indicates the keys and quantities delivered, date and to whom they were delivered. Provide a copy of this receipt with your final submittal. The consultant will make inspections to assure that keys are not compromised and if they may have been because they were left unattended in panels, new locks will be required.

4. Enclosures shall be fitted by the manufacturer with cover operated, corrosion-resistant tamper switches to actuate an alarm signal before access to equipment within the enclosure is gained. The tamper switch mounting hardware shall be concealed so that the location of the switch cannot be visually detected from the exterior of the enclosure.

F. SPARE PARTS

1. Provide, with the initial submittal, a list of all parts in the system and state the price that each part will be sold to the Owner for during the 12-month period following acceptance of the system. If no list is submitted, it shall be assumed that the components will be sold to the owner during the construction and warranty period for no more than cost plus (10) ten percent.

G. MANUFACTUER'S NAMEPLATES

1. Manufacturer's nameplates: securely and permanently affixed to each major component of the security system, and shall be indented, embossed or silk screened in a high quality and unobtrusive way acceptable to the Consultant providing lasting identification. Each nameplate shall, as a minimum, contain the manufacturer's name and the complete model number or serial number of the component as currently available and identified in current publications or catalogues. The Contractor shall not affix a nameplate for his own firm or a firm other than the manufacturer while concealing the name and address of the true manufacturer of the product nor shall the Contractor purchase and install private label products, i.e., a DSC keypad with his own company name. This provision will assist the Owner in obtaining support and service in the future direct from the manufacturer of the component if the installer is no longer in business. If, upon acceptance testing specified keypads and control panel enclosures bear the name of a firm other than the manufacturer, the Contractor will remove and replace them at his own expense. Nothing herein requires the installer to provide additional nameplates but prohibits him from removing existing nameplates and applying his own with a different name making it difficult to locate the true manufacturer of the part.

PART 3 INSTALLATION

A. DETECTION AND ANNUNCIATION DEVICES

1. Device Placement: Coordinate with the architect when a discrepancy or problem is noted or when exact location is not indicated. Discrepancies include but are not limited to devices that show where ducts prevent mounting or other similar issues. Do not move devices to any location if you feel that doing so will reduce security and not provide the quality of coverage being afforded by the specified location. When the intent of the device is not obvious, inquire of the security consultant who will advise as to the intent. If instructed to move a device by the architect or others, and the move might reduce security, submit a formal "request for information" to the security consultant so an alternate solution can be identified.

2. It may be necessary, although unlikely, in some locations due to ducts, lights or other ceiling level obstructions to stub down detectors. When this is required it shall be done by the contractor. Your bid shall include the cost of subbing down or adjusting the location of cameras and detectors as required.

3. All equipment, detectors, cameras, monitors, cabinets and other components provided and installed by the security contractor will be anchored in place using a means capable of holding twice the weight of the device being anchored to assure seismic stability. Equipment racks shall be provided with hardware manufactured by the supplier of the rack capable of stabilizing the rack to prevent it from falling over in an earthquake. Seismic stabilizing methods shall be shown on the shop drawings.

B. PROGRAMMING BY CONTRACTOR

1. Provide all programming of all systems provided under this specification including alarm annunciation descriptors, CCTV system time and date, camera IP addresses and camera system preferences, graphic floor plans for the access system, and up to 250 of the 500 supplied access cards, etc.

2. Work with the owner in preparing planning sheets for programming so partition, point and place descriptions meet their needs.

3. The alarm installer shall not retain a password or "back door" for operating the system without the knowledge of the owner.

4. The device schedule clearly defines groups of alarm devices that shall be armed and disarmed as groups. Multiple control panels permit sufficient partitions to meet the requirements of the schedules. Do not deviate from this partitioning and alarm shunting plan. Each detector is numbered on the drawing and device schedule. Each individual number is a separate alarm point. Zone the system as specified unless changes are approved by the owner and the consultant.

a. For purposes of this specification, “zone” does not refer to a device point address as might traditionally be defined. Zone refers to alarm shunt group. When a “zone” is shunted, all detectors and local audible alarms in that defined group are shunted. A zone can be armed and disarmed by a keypad command code in a user-friendly manner. Zone, partition and shunt groups are used interchangeably. “Point” refers to a point address for an individual device.

b. On device schedules, the partition (shunt group or zone) number and device number can be determined. Reference the schedule which is part of the drawings to indicate which device is assigned to which zone or group on the control panel. The drawings and schedules reference each detector or device by number, such as 1-4 or 4-6. The first number identifies the partition, the second number identifies the device or point on that partition.

c. The only times where it is acceptable to assign more than one device to a point address is when so indicated on the schedule. A door with a contact on each leaf will be identified as "A & B", with "A" being a contact on one leaf and "B" being a contact on the other leaf and both annunciating as one point when either leaf is opened. Panic buttons and other 24-hour devices shall be assigned to the 24 hour panic zones on the panels. Device 2-3 A&B therefore refers to partition 2, device number 3, where there are two contacts, one on each of the two-leaf door. NOTE: On doors with a card reader, the door contact is a double pole, double throw contact. On these devices, if the partition number was 2-3 A&B, a second number appears under the 2-3 A&B. That number is the device number for the second set of contacts in the DPDT contact, i.e., one pole is 2-3 A&B and the other pole is referenced on the plans and schedules as the second number

5. Program the system so alarms are not transmitted to the central station during the daytime hours to be determined by the owner but shall be transmitted off site during other hours. During these hours, alarms still annunciate on all keypads. Certain devices may require programmed entry/exit delays.
6. Any keypad on a DSC panel will arm, disarm and annunciate any partition on that control panel. See drawings for keypad locations. Keypads are referred to by number also. K-1 refers to keypad #1 on panel that building’s panel. If the building has two keypads, the second will be K-2.
7. Each building’s devices are numbered separately is numbered separately.
8. All door contacts are to be installed concealed in the door and not surface mounted. No new conduit may be added on the surface of walls or door frames without the written approval of the architect and security consultant. The security contractor shall closely schedule all door installations with the general contractor and be present when doors are set and grouted to assure that accommodations are made for security conduit. Failure to comply will not be an excuse to mount contacts on the surfaces.

C. WIRE AND CABLE

1. Wire and Cable: For the alarm system, use Unshielded twisted pair type and, 18 gauge for burglar alarm devices and comply with pertinent sections of the National Electrical Code where applicable. See

manufacturer's wiring requirements in the Installation Guide. Do not exceed maximum wiring distance limitations. Wiring shall be neat and sturdy. Wires shall not be bent sharply where they enter insulating material. Wires shall be properly placed and supported to prevent undue stress on the conductors and terminals, and prevent any undue change in the position of conductors. All wires shall be tagged and coded indicating their use. It should note the alarm zone and/or point code number and transponder number.

2. All wires shall be color-coded and color codes shall be maintained throughout. Record drawings shall indicate color codes if they deviate from a standard plan. All wires used for security shall be a distinctive color to identify them among the wires in the cable tray. Red shall not be used for security as it is reserved for other purposes. Coordinate wire colors with others.

3. Signal Wires: Identified as to gauge and type and submitted for review with the shop drawing submittals. Cable terminal boxes shall be used for the splicing or termination of cables. Where alarm wires must be spliced (splicing is to be avoided except under the most unusual circumstances) the splice must be documented and indicated on the shop drawings and must be accessible for repair if the splice later becomes problematic. Tag spliced wires for quick identification.

4. Wiring within component enclosures and terminal cabinets shall be installed in a neat and workmanlike manner and shall be trained parallel with or at right angles to the sides and back of any enclosure or cabinet. All circuit conductors entering or leaving any enclosure or cabinet shall be connected to terminal blocks with each terminal marked in accordance with the wiring diagram for identification. Connections shall be soldered unless another method is specified by the manufacturer of the product involved. A terminal cabinet shall be installed where circuit risers originate or where any circuit tap is made. All wiring within the panel shall be readily accessible without removing any component parts.

D. CONDUIT

1. Conduit: As shown on the drawings. Minimum 3/4 inch for security or larger if indicated on drawings. See details for conduit requirements at risers and at devices.

2. Neutral conductors, ground conductors, conduits, junction boxes, cabinets, cable messengers and all non-current-carrying metallic parts of equipment: grounded in accordance with the manufacturer's requirements.

3. In the event conduit terminates in a location too close to a duct, light or other obstruction or where air flow will cause false alarms, seek the advice of the consultant regarding an alternate location for the detector. It is the responsibility of the Contractor to carefully review the reflected ceiling plans and be alert to field conditions which may result in false alarms and to alert the architect and security consultant so corrections can be made for him before work is done. In the event conduit is covered or obstructed by ducts or other obstructions it is the responsibility of the Contractor to move the conduit to the new location in the immediate vicinity as agreed by the security consultant or to stub down below the obstruction, at no additional cost. Coordinate conduit with other trades closely to prevent conflicts. When conduit terminates at the slab above but must be stubbed down in areas with unfinished ceilings, stub down as indicated on the plans at no additional cost.

E.POWER

1. Power all detectors from one power source per system in the room containing the control panels. The method of powering the equipment shall be defined in the shop drawing submittal. Do not use individual transformers in the field.

2. If additional electrical outlets in the security closet in the field are required, they shall be provided and installed by the Contractor at the Contractor's expense. Check detail drawings to see the outlets being provided in the security rooms for your use. Include any inadequacy of electrical power in your bid.

3. The alarm system shall be capable of operation for a period of no less than 4 hours with its standby battery system. Place batteries in metal boxes at the location of the control panel as shown on the detail drawings. Circuits powering the burglar alarm equipment shall be on the emergency power generator serving the building if the building has such a generator.

4. Cameras shall be powered over Ethernet.

F. ANNUNCIATION

1. Every device in the system shall annunciate on the keypad as its own point address except as noted.

2. Where there are multiple doors that indicate the same point on the plans with an a-b-c, etc. these doors may annunciate as one point. These are specified on the Device Schedule.

G. CENTRAL STATION

1. Submit with your proposal the annual cost of monitoring by a UL listed central station at the line security grade specified. The off-site UL listed central station must be compatible with the DSC alarm panel and must receive each point in the system by its own point address.

2. Dial up alarm transmissions shall be UL Grade “C”. Failure of the phone line in any way shall result in transmission of an alarm via a second phone line.

3. Coordinate your requirements for a phone line for alarm control panels with the architect.

H. DEVICE SCHEDULE

1. Do not bid this project without fully understanding the Device Schedule which specifies exact make and model of most equipment in this project.

END OF SECTION
Attachments Follow

ATTACHMENT "A"-- SUBMITTAL PARTS LIST

Device Type	Make and Model	Quantity for Use	Quantity for Spare	Unit Price

ATTACHMENT "B" SAMPLE SPECIFICATION COMPLIANCE STATEMENT

Date

Your Company Name
Your Company Address
Your Company Address 2
City, State, ZIP

RE: Insert name of the project and project number from specification header/footer here

Dear Sirs:

This is to certify that our bid on the above project contains no substitutions, alternates, or exceptions.

Sincerely,

Authorized Representative's Signature

Authorized Representative's typed name

OR

Dear Sirs:

This is to certify that our bid on the above project contains the following substitutions, alternates, or exceptions. I certify that no substitutions or alternates were made unless they were authorized in the specification.

Specification Section Substitution, alternate or exception taken

Sincerely,

Authorized Representative's Signature

Authorized Representative's typed name

ATTACHMENT "C"—SHOP DRAWING SUBMITTAL CHECKLIST

The following must be included on the shop drawings:

___ Use the floor plans for the most recent set of plans provided to you. Include all sheets.
___ Substitute your detail drawings for our detail drawings; show wiring at each device
___ Substitute your block diagram for our block diagram
___ Include in your detail for each device the method used to achieve the seismic stabilization required in the spec for each device type.
___ Include a riser diagram for each system (alarm, access control, CCTV, etc.)
___ Include a panel loading chart for each alarm and reader control panel
___ Retain the device numbering scheme and symbols used in the bid drawings
___ Change the title block to your company's own title block
___ Indicate "Shop Drawings" and include the submittal date
___ Indicate conduit fill
___ Indicate cable types and gauge for each device type
___ Show end of line resistors and resistor value at resistor location
___ Modify the Device and Equipment Schedules with substituted device where authorized; Bubble the substitution
___ Provide details of power and power supplies
___ Show battery details for all batteries provided. Show how you arrived at this battery size.
___ Where the bid document indicate shunt groups or zoning, show the shunt groups or zoning to verify that you are retaining our plan or changing it. Bubble changes from our scheme.

ATTACHMENT "D" SAMPLE LETTER CERTIFYING COMPLETION

Date

Your Company Name
Your Company Address
Your Company Address 2
City, State, ZIP

RE: Insert name of the project and project number from specification header/footer here

Dear Sirs:

This is to certify that our work in the above project is complete in every way. We have:

1. Finished all work and delivered all materials.
2. We have made all modifications to drawings requested and they have been approved.
3. The security consultant and architect have signed off on all as built drawings and related submittals.
4. We have completed all punch listed items as identified on previous site visits by the design team.
5. We have submitted all manuals in the quantities and format required and they have been approved.
6. We have coordinated all adjustments and repairs by other sub-contractors that affect our work and those adjustments and repairs have been made.
7. We have completed all owner training sessions specified.
8. We have delivered all keys to panels and enclosures.
9. We have delivered all test equipment and spare parts specified.
10. All walk test lights and sensitivity on detectors are set as specified.
11. We have removed all unused supplies, materials, and trash from the jobsite that is associated with our work or area of responsibility.
12. We have obtained all permits.
13. The connection to the central station, if one was specified, is fully functioning as specified.
14. The back-up cellular or similar dialer account, if one is included in this work, has been activated and the item is properly functioning.
15. We have completed patching, painting and repairing as specified.
16. All software and firmware is the current version on alarm, access control and CCTV systems.
17. All programming specified has been completed.

We certify that the project is complete for turn over to the owner on _____ (insert date) and that this shall be the date used for commencement of the warranty

Sincerely,

Authorized Representative's Signature

Authorized Representative's typed name

SECTION 283111 - DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM

PART 1 GENERAL

1.1 DEFINITIONS

A. FACP: Fire Alarm Control Panel.

B. NICET: National Institute for Certification in Engineering Technologies.

C. PC: Personal computer.

D. SLC: Signal line circuit.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product, including furnished options and accessories.

1. Include construction details, material descriptions, dimensions, profiles, and finishes.
2. Include rated capacities, operating characteristics, and electrical characteristics.

B. Shop Drawings: For fire-alarm system.

1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
2. Include plans, elevations, sections, details, and attachments to other work.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations.
4. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
5. Detail assembly and support requirements.
6. Include voltage drop calculations for notification-appliance circuits.
7. Include battery-size calculations.
8. Include input/output matrix.
9. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
10. Include floor plans to indicate final outlet locations showing address of each device. Show size and route of cable and conduits and point-to-point wiring diagrams.
11. Include performance parameters and installation details for each detector.
12. Duct Smoke Detectors: Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them, in accordance to manufacturer's written recommendations.

    a. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
    b. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.

Retain one of first three subparagraphs below.

    c. Show field wiring required for HVAC unit shutdown on alarm.

13. Air-Sampling Smoke Detectors: Provide program report showing that air-sampling detector pipe layout balances pneumatically within the airflow range of the air-sampling detector. Provide plans showing air-sampling detector pipe routing.
14. Voice Evacuation System: Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.

C. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:

a. Trained and certified by manufacturer in fire-alarm system design.
b. NICET-certified, fire-alarm technician; Level III minimum.
c. Licensed or certified by authorities having jurisdiction.

D. Delegated-Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.
2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Seismic Qualification Certificates: Comply with requirements in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following[and deliver copies to authorities having jurisdiction]:

a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.

c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
d. Riser diagram.
e. Device addresses.
f. Air-Sampling Detectors: Air-sampling system sample port locations and modeling program report showing layout meets performance criteria.
g. Record copy of site-specific software.
h. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:

1) Equipment tested.
2) Frequency of testing of installed components.
3) Frequency of inspection of installed components.
4) Requirements and recommendations related to results of maintenance.
5) Manufacturer's user training manuals.

i. Manufacturer's required maintenance related to system warranty requirements.
j. Abbreviated operating instructions for mounting at FACP and each annunciator unit.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On solid-state drive or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
3. Smoke Detectors, Heat Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
4. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
5. Keys and Tools: One extra set for access to locked or tamperproofed components.
6. Audible and Visual Notification Appliances: One of each type installed.
7. Air-Sampling Detectors:

a. Filters: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
b. Fan: Quantity equal to one for every five detectors, but no fewer than one unit of each type.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level II technician.

C. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed and a FM Global-placarded alarm company.

D. Source Limitations for Fire-Alarm System and Components: Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.

1. Components shall be compatible with, and operate as an extension of, existing system.

E. Comply with NFPA 70 and NFPA 72.

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. All components provided shall be listed for use with the selected system.

G. Seismic Performance: Comply with requirements in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

PART 2 Retain subparagraph below to define the term "withstand" as it applies to this Project. Definition varies with type of building and occupancy and is critical to valid certification. Option is used for essential facilities where equipment must operate immediately after an earthquake.PRODUCTS

2.1 GENERAL FIRE-ALARM SYSTEM REQUIREMENTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Retain "Basis-of-Design Product" Paragraph and list of manufacturers below to identify a specific product or a comparable product from manufacturers listed. Retain option and delete insert note if manufacturer's name and model number are indicated on Drawings.

1. Basis of Design Manufacturer:

a. Edwards EST

2. Alternate manufacturers shall be submitted 10 days prior to bid for acceptance by Owner:

a. Siemens
b. SimplexGrinnell
c. Notifier

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. System Operation: Refer to the Drawings for fire-alarm sequence of operations.

2.3 FIRE-ALARM CONTROL PANEL

A. Fire-Alarm Control Panel: Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864. System software and programs, including system database, logic, and operating system and event history, shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies. The FACP shall provide a minimum 500-event history log. Include a real-time clock for time annotation of events on the event recorder and printer. The FACP shall be listed for connection to a central-station signaling system service.

1. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
3. Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at FACP and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, three line(s) of 40 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

C. Pathways and Circuits: NFPA 72.

1. Initiating-Device Circuits: Class A .
2. SLCs: Class A.
3. Notification-Appliance Circuits: Class A .
4. Ethernet and Network Communications: [Class C.]
5. Pathway Survivability: For circuits, conductors,or other means of connecting two location.

a. Systems Employed for Occupant Relocation or Partial Evacuation: Level 2.
b. Systems Not Employed for Occupant Relocation or Partial Evacuation: Level 2.
c. Two-Way Communication Systems: Level 2.
d. Area of Refuge Communications: Level 2.
e. Elevator Emergency Communications: Level 2.

6. SLCs: Install no more than 100 addressable devices on each SLC.

D. Serial Interfaces:

1. RS-485:

a. operation using point ID DACT.
b. Remote annunciators
c. Ethernet module
d. Printer.

2. RS-232:

a. Air-sampling smoke detection high level interface connection.
b. Voice evacuation interface.

3. PC Configuration port: One USB port.

E. Presignal Alarm System: Comply with NFPA 72, an alarm signal initiates an audible and visual alarm and indication at the FACP, in a constantly attended location. Activation of an initiation device connected as part of a preaction system shall be annunciated at the FACP only, without activation of the general evacuation alarm. If the user determines the alarm is false, the user cancels the alarm event. If the alarm is verified, or after expiration of the time delay sequence, the general alarm shall be activated.

F. Positive Alarm Sequence Verification: Comply with NFPA 72, an automatic detector device initiates audible and visible indication of an "alarm-verification" signal at FACP. If the user determines the alarm is false, the user cancels the alarm event. The general alarm is activated if the alarm is verified, a second initiating device is activated, or the time delay sequence expires.

G. Notification Appliance Circuits: Comply with NFPA 72.

1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
2. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

H. Elevator Recall:

1. Elevator recall shall be initiated only by one of the following alarm-initiating devices:

a. Elevator lobby detectors except the lobby detector on the designated floor.
b. Smoke detector in elevator machine room.
c. Smoke detectors in elevator hoistway.

2. Elevator controller shall be programmed to move the cars to the alternate recall floor if lobby detectors located on the designated recall floors are activated.
3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.

a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.

I. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall be connected to fire-alarm system.

J. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory , and print out the final adjusted values on system printer.

K. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

L. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided as a special module that is part of fire alarm control unit. Allow number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711.

1. Multiple-Zone Capability: Allow the application of, and evacuation signal to, indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
2. Tone and Messages: Programmable tone and message sequence selection, with standard digitally recorded messages for "Evacuation" and "All Clear." Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification-appliance circuits of FACP.
3. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.
4. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.

M. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

N. Secondary Power: 24-V dc supply system with sealed lead calcium batteries, automatic battery charger, and automatic transfer switch. Provide battery as part of fire alarm panel.

2.4 DATA GATHERING PANELS

Retain first paragraph below and revise general features to suit Project. Coordinate with implementation details and Drawings. Addressable horns are available for notification appliance circuits; insert a subparagraph if required. Effective October 1, 2005, UL 864 requires compliance with software integrity requirements.

A. Initiating Device Circuit: Functions for monitoring of addressable initiation devices equal to that of FACP.

B. Notification Appliance Circuit: Functions for notification appliances, control relays, etc. equal to that of FACP.

C. Printer: Includes printer port and capable to generate printout for all incident on entire fire alarm system, equal to that of FACP.

D. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals shall be powered by 24-V dc source. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

E. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

2.5 INITIATING DEVICES

A. Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box. Double-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to FACP. Key- or wrench-operated station reset switch.

1. Indoor Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
2. Weatherproof Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

2.6 CARBON MONOXIDE DETECTORS

A. Carbon Monoxide Detectors: Comply with UL 2076, listed for connection to fire-alarm system. Mounts to twist-lock base interchangeable with smoke-detector bases, and includes integral LED indicating light indicating detector has operated and power-on status. Detector shall provide alarm contacts and trouble contacts; detector sends trouble signal when nearing end-of-life, power supply problems, or internal faults. Provide means for addressable connection to fire-alarm system.

1. Testing: Testable by introducing test carbon monoxide into the sensing cell. Test button simulates an alarm condition.
2. Mounting: Adapter plate for outlet box mounting.
3. Testable by introducing test carbon monoxide into the sensing cell.
4. Detector shall provide alarm contacts and trouble contacts.
5. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
6. Comply with UL 2075.
7. Locate, mount, and wire according to manufacturer's written instructions.
8. Provide means for addressable connection to fire-alarm system.
9. Test button simulates an alarm condition.

2.7 MULTICRITERIA DETECTORS

A. Heat Detector: Comply with UL 521, listed for use with FACP; operating at 24-V dc, nominal. Temperature sensors shall test for and communicate the sensitivity range of the device. Includes integral addressable module arranged to communicate detector status (normal, alarm, or trouble) to FACP, and integral LED indicating light indicating detector has operated and power-on status. Detector housing with twist-lock module connects to a fixed base with terminals for connection to building wiring.

Coordinate "Heat Detector, Combination Type" and "Heat Detector, Fixed-Temperature Type" paragraphs below with Drawings. Revise fixed-temperature values to suit applications and NFPA 72 requirements, or delete values below and indicate on Drawings. See Editing Instruction No. 9 in the Evaluations for discussion about detector locations.

1. Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
2. Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F.

B. Multicriteria Detectors: Listed for use with FACP; operating at 24-V dc, nominal. Includes integral addressable module arranged to communicate detector status (normal, alarm, or trouble) to FACP, and integral LED indicating light indicating detector has operated and power-on status. Detector housing with twist-lock module connects to a fixed base with terminals for connection to building wiring. Automatically adjusts its sensitivity by means of drift compensation and smoothing algorithms. The detector shall send trouble alarm if it is incapable of compensating for existing conditions.

C. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

D. Automatically adjusts its sensitivity by means of drift compensation and smoothing algorithms. The detector shall send trouble alarm if it is incapable of compensating for existing conditions.

E. Test button tests all sensors in the detector.

1. Operator Access: An operator at FACP, having the designated access level, shall be able to manually access the following for each detector:

    a. Primary status.
    b. Device type.
    c. Present sensitivity selected.
    d. Sensor range (normal, dirty, etc.).

2. Sensors: The detector shall be comprised of four sensing elements including a photoelectric smoke sensor, a carbon monoxide sensor, an infrared sensor, and a heat sensor; each sensor shall comply with the requirements described in this Section and shall be separately listed according to requirements for its detector type.. Test button tests all sensors in the detector.
3. Smoke sensor shall be photoelectric type as described in "System Smoke Detectors" Article.
4. Carbon monoxide sensor shall be as described in "Carbon Monoxide Detectors" Article.
5. Heat sensor shall be as described in "Heat Detectors" Article.

6. Each sensor shall be separately listed according to requirements for its detector type.

2.8 NONSYSTEM SMOKE DETECTORS

A. Nonsystem Smoke Detectors: Listed as compatible with the fire-alarm equipment installed or shall have a contact closure interface listed for the connected load; detectors shall meet the monitoring for integrity requirements in NFPA 72.

1. Single- and Multi- Station Smoke Detectors: Comply with UL 217; suitable for NFPA 101, residential occupancies; operating at 120-V ac with 9-V dc battery as the secondary power source. Provide with "low" or "missing" battery chirping-sound device. Includes integral LED indicating light indicating detector has operated and power-on status. Detector housing with twist-lock module connects to a fixed base with terminals for connection to building wiring. Resetting or readjustment after actuation to restore the detector to normal operation shall not be required. Test switch with push to test; simulates smoke at rated obscuration.
2.

   a. Auxiliary Relays: One Form C, rated at 0.5 A.
   b. Audible Notification Appliance: Piezoelectric sounder rated at 90 dBA at 10 feet according to UL 464.
   c. Visible Notification Appliance: 177-cd strobe.
   d. Combination Smoke- and Heat-Detectors: Heat sensor, 135 deg F combination rate-of-rise and fixed temperature.
   e. Tandem Connection: Allow tandem connection of number of indicated detectors; alarm on one detector shall actuate notification on all connected detectors.

3. Single-Station Duct Smoke Detectors: Comply with UL 268A; operating at 120-V ac. LED or infrared light source with matching silicon-cell receiver. Smoke obscuration between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) when tested according to UL 268A. Detector housing with twist-lock module connects to a fixed base with terminals for connection to building wiring. The fixed base shall be designed for mounting directly to air duct.
4.

   a. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; listed for use with the supplied detector.
   b. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
   c. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.9 NOTIFICATION APPLIANCES

A. General Requirements: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.
2. Housing: Semirecessed , factory finished,
3. Mounting: Wall mounted and ceiling mounted, as indicated on Drawings.

B. Visible Notification Appliances: Comply with UL 1971, LED strobe lights , with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- high letters on the lens. Flashing shall be in a temporal pattern, synchronized with other units. Strobe leads factory connected to screw terminals. Provide candela ratings required for full coverage of spaces for device locations indicated on Drawings

1. Standard Light Output Rating: 15/30/75/110 cd for wall-mounted units and15/30/75/95 cd for ceiling-mounted units, selectable in the field.
2. High Light Output Ratings: 135 177 185 cd, as indicated on Drawings.
3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.

C. Voice/Tone Speaker Notification Appliances: Comply with UL 1480. Locate speakers for voice notification to provide the intelligibility requirements of the "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.

1. High-Range Units: Rated 2 to 15 W.
2. Low-Range Units: Rated 1 to 2 W.
3. Matching Transformers: Tap range matched to acoustical environment of speaker location.

D. Exit Marking Audible Notification Appliance: Meet audibility requirements in NPFA 72. Provide exit marking audible notification appliances at the entrance to all building exits.

2.10 EMERGENCY CONTROL AND FIRE SAFETY FUNCTIONS

The ICC requires that smoke detectors in "Door Controls" Paragraph below be system detectors. NFPA 101 and NFPA 5000 allow them to be nonsystem detectors.

2.11 SUPERVISING STATION ALARM TRANSMISSION

A. Digital Alarm Communicator Transmitter: Transmitter shall be acceptable to the remote central station and shall comply with UL 632.

1. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from FACP and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal. Self-test conducted automatically every 24 hours with report transmitted to central station.
2. Local functions and display at the digital alarm communicator transmitter shall include the following:

a. Verification that both telephone lines are available.
b. Programming device.
c. LED display.
d. Manual test report function and manual transmission clear indication.
e. Communications failure with the central station or FACP.

3. Digital data transmission shall include the following:

    a. Address of the alarm-initiating device.
    b. Address of the supervisory signal.
    c. Address of the trouble-initiating device.
    d. Loss of ac supply.
    e. Loss of power.
    f. Low battery.
    g. Abnormal test signal.
    h. Communication bus failure.

4. Secondary Power: Integral rechargeable battery and automatic charger.

2.12 NETWORK COMMUNICATIONS

A. Provide network communications for fire-alarm system according to fire-alarm manufacturer's written requirements and requirements in NFPA 72 and NFPA 70. Provide integration gateway using BACnet or Modbus for connection to building automation system.

2.13 SYSTEM DEVICES AND ACCESSORIES

A. Remote Annunciator: Annunciator functions, display type, and functional performance shall match those of FACP for alarm, supervisory, and trouble indications. Manual switching functions shall match those of FACP, including acknowledging, silencing, resetting, and testing.

1. Mounting: Flush cabinet, NEMA 250, Type 1.

Retain "Manufacturers" Paragraph and list of manufacturers below to require products from manufacturers listed or a comparable product from other manufacturers.Retain "Basis-of-Design Product" Paragraph and list of manufacturers below to identify a specific product or a comparable product from manufacturers listed. Retain option and delete insert note if manufacturer's name and model number are indicated on Drawings.Retain "Graphic Annunciator Panel" or "Graphic Annunciator Workstation" Paragraph below.

B. Addressable Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts. Include address-setting means on the module.

Retain "Integral Relay" Paragraph below for elevator recall, shutdown duty, or other relay functions.

C. Control Relay Module: Capable of providing a direct signal to perform functions or operated devices as required in the Sequence of Operation. Provide a minimum of two normally open and two normally closed contacts available for field wiring, and allow FACP to switch relay contacts on command.

1. Listed for controlling HVAC fan motor controllers.

D. Remote Status and Alarm Indicator: With LED visual indicators for status and alarm for devices not readily visible from normal viewing position.

E. System Printer: Listed and labeled as an integral part of fire-alarm system.

1. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

2.14

A. Device Guards: Welded wire mesh of size and shape for the initiating device, notification appliance, or other device requiring protection. Factory fabricated and furnished by device manufacturer, with paint color to match the protected device.

2.15 FIRE ALARM WIRE AND CABLE

Retain "Manufacturers" Paragraph and list of manufacturers below to require products from manufacturers listed or a comparable product from other manufacturers.

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Retain "Basis-of-Design Product" Paragraph and list of manufacturers below to identify a specific product or a comparable product from manufacturers listed. Retain option and delete insert note if manufacturer's name and model number are indicated on Drawings.

1. Comtran Corporation.
2. Honeywell Cable.
3. West Penn Wire.

NFPA 70 permits wire sizes down to No. 16 AWG.

B. SLCs: Twisted, shielded pair, not less than No. 18 AWG.

Retain subparagraph below if use of cable is an option.

C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 150 deg C, color-coded insulation.

NFPA 70 permits wire sizes down to No. 18 AWG.

1. Low-Voltage Circuits: No. 16 AWG, minimum.
2. Line-Voltage Circuits: No. 12 AWG, minimum.

Retain subparagraph below if use of cable is an option.

3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NTRL listed for fire alarm and cable tray installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION

A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

1. Devices placed in service before all other trades have completed cleanup shall be replaced.
2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

B. Floor-Mounted Equipment: Install on concrete base. Comply with requirements in Section 260529 ÓHangers And Supports For Electrical Systems.•

1. Install seismic bracing. Comply with requirements in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

C.

D. Wall-Mounted Equipment: Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

E. Manual Fire-Alarm Boxes:

1. Install manual fire-alarm box in the normal path of egress within 60 inches of the exit doorway.
2. Mount manual fire-alarm box on a background of a contrasting color.
3. The operable part of manual fire-alarm box shall be between 42 inches and 48 inches above floor level. All devices shall be mounted at the same height unless otherwise indicated.

F. Detectors: Install a cover on each detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.

1. Smoke Detectors: Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
2. Heat Detectors: Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
3. Smooth ceiling spacing shall not exceed 30 feet.
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A or Annex B in NFPA 72.
5. HVAC: Locate detectors not closer than 36 inches from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.

G.

1. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches long shall be supported at both ends. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.
2.
3. Carbon-Monoxide Detectors: Locate, mount, and wire according to manufacturer's written instructions.
4. Air-Sampling Smoke Detectors: Support pipes at not more than 60-inch (1520-mm) centers. If using multiple pipe runs, the runs shall be pneumatically balanced.
5. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.
6. Single- and Multi- Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.

H. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.

I. Notification Appliances: Install wall- mounted devices so that entire lens is not less than 80 inches and not greater than 96 inches above finished floor , but not less than 6 inches below the ceiling. Install all device types at the same height unless otherwise indicated.

1. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.

J. Antenna for Digital Radio Alarm Transmitter: Mount to building structure where indicated. Use mounting arrangement and substrate connection that resists 100-mph wind load with a gust factor of 1.3 without damage.

K. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

3.3 WIRING INSTALLATION

A. Comply with NECA 1 and NFPA 72.

Retain one of first two paragraphs below and coordinate with Drawings. Delete both if wiring methods for system are indicated on Drawings.

B. Wiring Method: Install wiring in metal raceway according to Section 260533 "Raceways and Boxes for Electrical Systems."

1. Wiring above recessed ceilings and in nonaccessible locations may be routed exposed. Exposed pathways located less than 96 inches (2440 mm) above the floor shall be installed in metal raceway.
2. Install plenum cable in environmental air spaces, including plenum ceilings.
3. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.
4. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
5. Fire-Rated Cables: Use of 2-hour, fire-rated fire alarm cables, NFPA 70, Type MI is permitted.
6. SLCs: Power-limited fire alarm cables shall not be installed in the same cable or raceway as SLCs.

C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

E. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

For Class A circuits, provide separate conduits or cable for outgoing and return conductors; coordinate with Drawings. Retain first paragraph below if required.

F. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.

Retain paragraph below if system is monitored by remote central station or for remodeling and alteration projects where fire alarm system exists and new connections are made to central-station transmitter. Supervised circuits are required for alarm and supervisory functions.

G. Wiring to Remote Alarm Transmitting Device: 1-inch (25-mm) conduit between the fire alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.4 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Alarm-initiating connections to the following:

a. Smoke dampers.
b. Magnetically held-open doors.
c. Electronically locked doors and access gates in the path of egress.
d. Elevator recall system.
e. Emergency lighting control.
f. Emergency shutoffs for gas and fuel supplies.

2. Supervisory connections to the following:

a. Valve supervisory switches.
b. Low-air-pressure switch of each dry-pipe sprinkler system.
c. Elevator shunt-trip breaker.
d. Data communication circuits for connection to building management system.
e. Data communication circuits for connection to mass notification system.
f. Fire-suppression system locations.
g. Fire-pump power failure, including a dead-phase or phase-reversal condition.
h. Fire-pump engine control panel.
i. Supervisory connections at generator.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install framed instructions in a location visible from FACP. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Instructions: Computer generated instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

3.6 GROUNDING

A. Ground FACP and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to FACP.

B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.7 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by authorities having jurisdiction.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Visual Inspection: Conduct visual inspection prior to testing.

    a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
    b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

E. Fire-alarm system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

H. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.8 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.9 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 283111

SECTION 310000
EARTHWORK

PART 1 - GENERAL

1.01 DESCRIPTION

A. Provide facilities, labor, materials, tools, equipment, appliances, transportation, supervision, and related work necessary to complete the work specified in this section, and as shown on the Drawings.

B. Work performed under this Section of the Specifications shall be subject to the General Conditions, Supplementary Conditions and Division 01 General Requirements of the Contract Documents.

C. The work of this section includes but is not necessarily limited to:

1. Excavation, fill, and backfill, as indicated or required, including compaction
2. Excavation, as required, to the lines and grades indicated on the Drawings
3. Excavation and offsite disposal of unsuitable or excess materials unless on-site locations are designated. Excavation shall include removal and satisfactory disposal of all unclassified material encountered throughout the site.
4. Rough grading, including placement, moisture conditioning, and compaction of fills and backfill
5. Placement of base and subbase course materials under structures, pavements, slabs, and footings, including compaction
6. Trench excavation, bedding, and backfill for structures, foundations, and utilities, including compaction
7. The removal, hauling and stockpiling of suitable excavated materials for subsequent use in the work. Stockpiling shall include protection to maintain materials in a workable condition
8. Rehandling, hauling, and placing of stockpiled materials for use in refilling, filling, backfilling, grading, and such other operations
9. Protection and preservation of all existing buildings, pavements, and utilities to remain
10. Furnishing and installing all sheeting, shoring, and bracing of structural and trench excavations and its satisfactory removal, unless otherwise directed to have it remain in place
11. Environmental controls
12. Providing products in sufficient quantities to meet the project requirements
13. Providing adequate pumping and drainage facilities to keep the work area sufficiently dry
14. Obtaining all required permits, licenses, and approvals from appropriate municipal and utility authorities, prior to commencement of the work of this Section, and paying costs incurred therefrom

D. Provision of facilities, labor, materials, tools, equipment, appliances, and related work necessary to provide and maintain erosion control during construction operations. All erosion control measures shall be installed prior to earthwork operations and shall be maintained according to plans and other sections of the specifications.

1. Refer to Section 312500 – EROSION AND SEDIMENTATION CONTROLS

E. Contractor shall be responsible for notifying all affected utility companies before starting work.

1.02 RELATED SECTIONS

A. Carefully examine the Contract Documents for requirements which affect the work in this Section. Other Specification Sections which directly relate to the work of this Section include, but are not limited to, the following:

1. Section 018900 – SITE CONSTRUCTION PERFORMANCE REQUIREMENTS
2. Section 311000 – SITE CLEARING
3. Section 312500 – EROSION AND SEDIMENTATION CONTROLS
4 Section 321100 – BASE COURSES (PAVEMENTS)
5. Section 333900 – SANITARY UTILITY SEWERAGE STRUCTURES
6. Section 334000 – STORM DRAINAGE UTILITIES

1.03 REFERENCE STANDARDS

A. References herein are made in accordance with the listed specific standards of the following organizations and work under this Section shall conform to the latest edition, unless modified by these Specifications.

1. American Association of State Highway and Transportation Officials (AASHTO):
   a. T11 – Standard Method of Test for Materials Finer Than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing
2. ASTM International (ASTM):
   a. D422 (2007) Standard Test Method for Particle-Size Analysis of Soils
   b. D1557-12 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort
   c. D5268-10 Standard Specification for Topsoil Used for Landscaping Purposes
3. American Concrete Institute (ACI):
   a. 229R-13 Report on Controlled Low-Strength Materials

4. New York State DOT Regulations and Specifications.

1.03 LAWS AND REGULATIONS

A. Work shall be accomplished in accordance with regulations of local, county, state and federal agencies or utility company standards as they apply.

1.04 QUALITY ASSURANCE

A. The Owner may retain and pay for the services of an independent testing and inspection firm and/or a Geotechnical Consultant to perform on-site observation and testing during the various phases of the construction operations. The scope of services will be determined by the Owner and the independent testing and inspection firm and/or the Geotechnical Consultant, and results will be provided to the Contractor. The Owner reserves the right to modify or waive the services of the independent testing and inspection firm and/or the Geotechnical Consultant. The services of an independent testing firm and/or Geotechnical Consultant may include, but not necessarily be limited to, the following:

1. Observation during excavation and dewatering of building areas and controlled fill areas.
2. Laboratory testing and analysis of fill materials as specified herein and proposed by the Contractor for incorporation into the Work.
3. Observation of construction and performance of water content, gradation and compaction tests at a frequency and locations that the independent testing and inspection firm and/or the Geotechnical Consultant may require. The results of these tests will be submitted to the Owner, Engineer, and Contractor on a timely basis so that action can be taken to remedy

indicated deficiencies. During the course of construction, the independent testing and inspection firm and/or the Geotechnical Consultant will advise the Owner in writing, if at any time in their opinion, the Work hereunder is of unacceptable quality. Failure of independent testing and inspection firm and/or the Geotechnical Consultant to give notice, shall not excuse the Contractor from latent defects discovered in his work.

B. The Contractor shall make provisions for allowing observations and testing of Contractor's work by the independent testing and inspection firm and/or the Geotechnical Consultant.

1. The presence of the independent testing and inspection firm and/or the Geotechnical Consultant does not include supervision or direction of the actual work of the Contractor, and his employees or agents. Neither the presence of the independent testing and inspection firm and /or the Geotechnical Consultant, nor any observations and testing performed by them, nor failure to give notice of defects shall excuse the Contractor from defects discovered in his work.

C. Costs related to retesting due to unacceptable qualities of work and failures discovered by testing shall be paid for by the Contractor at no additional expense to Owner, and the costs thereof will be deducted by the Owner from the Contract Sum.

D. Whenever floodplain or wetland compensation areas are designated on the plans, grading elevations are to be considered critical to the volumetric calculations and shall be constructed by the Contractor in strict conformance with the indicated grades.

1.05 SUBMITTALS

A. Submit, in an airtight container for the testing laboratory, a 50-pound sample of each type of off-site fill material that is to be used at the site. Submit samples a minimum of one week prior to use of proposed material at the site. Submit samples to the testing laboratory and/or the Geotechnical Consultant (copy of these transmittal forms shall be simultaneously sent to Engineer) or if no testing laboratory and/or Geotechnical Consultant is identified, then the Engineer shall be the recipient of the samples. Use of these proposed materials by the Contractor prior to testing and approval shall be at the Contractor's risk.

B. The Engineer will determine the suitability of all materials.

C. Submit the name of each material supplier and specific type and source of each material. Any change in source throughout the project will require approval of the Owner or Engineer.

D. For use of geotextile fabrics or geogrids, submit manufacturer's product data including material properties for approval by the Engineer.

1.06 COORDINATION

A. Prior to start of earthwork the Contractor shall arrange an on-site meeting with the Engineer, the Owner's Representative, the independent testing firm, and/or the Geotechnical Consultant for the purpose of establishing the Contractor's schedule of operations and scheduling observation and testing procedures and requirements.

B. As construction proceeds, the Contractor shall be responsible for notifying the Owner and Engineer prior to the start of earthwork operations requiring observation and/or testing.

1.07 SUBSURFACE SOIL DATA

A. A geotechnical engineering report has been prepared by Tectonic Engineering Consultants, Geologists & Land Surveyors, D.P.C., dated April 15, 2020. This report is specifically not part of the Contract Documents but is available to bidders for informational purposes.

B. Review available logs of borings, test pit logs, jar soil samples, records of explorations and other pertinent data for the site. After obtaining Owner's permission, take whatever additional subsurface explorations deemed necessary at no expense to the Owner.

C. Subsurface soil data is provided for general information and is accurate only at the particular locations and times the subsurface explorations were made. It is the Contractor's responsibility to make interpretations and to draw conclusions based on the character of materials to be encountered and the impact on his work based on his expert knowledge of the area and of earthwork techniques.

D. The Drawings in the geotechnical report showing existing ground elevations are only for whatever use the Contractor may make of them with no responsibility on the part of the engineers, surveyors, the Owner, the Engineer, and/or their representatives for the accuracy and/or the reliability of the information given.

E. If a potential conflict exists between the Geotechnical Report and these technical Specifications, the Contractor shall, immediately upon its discovery, request clarification from the Owner’s Representative or the Engineer.

PART 2 – PRODUCTS

2.01 SUBGRADE

A. Subgrade is the material in excavation (cuts) and fills located below subbase, base course layer for slabs, sidewalks, pavement, and other improvements.

2.02 COMMON FILL / ORDINARY BORROW

A. Common Fill/Ordinary Borrow shall be friable soil containing no stone greater than two-thirds (2/3) the loose lift thickness with a maximum stone size of twelve (12) inches in diameter. The material shall be essentially free of trash, ice snow, tree stumps, roots, and organic materials. The soil shall contain no more than 15 percent passing the #200 sieve.

2.03 GRAVEL

A. Gravel shall consist of inert material that is hard, durable stone and coarse sand, free from loam, clay, surface coatings and deleterious materials, and shall conform to the following gradation:

Sieve (ASTM D422)	Percent Passing by Weight
*	100
1/2-inch	50 - 85
No. 4	40 - 75
No. 50	8-28
No. 200	0 - 10

2.04 SAND

A. Sand shall consist of clean, inert, hard, durable grains of quartz or other hard, durable rock, free from loam or clay, surface coatings and deleterious materials.

1. The allowable amount of material passing a No. 200 sieve as determined by AASHTO-T11 or ASTM D422 shall not exceed 10 percent by weight. The maximum particle size shall be 1/4-inch (i.e., 100 percent passing the No. 4 sieve).
2. In addition to the above criteria when sand is used for bedding concrete pavers and for utility bedding it shall conform to the following gradation:

Sieve (ASTM D422)	Percent Passing by Weight
No. 4	100
No. 8	80 – 95
No. 16	55 – 85
No. 50	0 – 35
No. 200	0 – 5

B. On Site Disposal System Leaching Area, Sand Fill Material shall consist of clean, inert, hard, durable grains of quartz or other hard, durable rock, free from loam or clay, surface coatings and deleterious materials.

1. A sieve analysis, using a No. 4 sieve, shall be performed on a representative sample of the fill. Up to 45% by weight of the fill sample may be retained on the No. 4 sieve. Sieve analyses also shall be performed on the fraction of the fill sample passing the No. 4 sieve, such analyses must demonstrate that the material meets the following gradation:

Sieve ASTM D422	Effective Particle Size	Percent Passing by Weight
No. 4	4.75 mm	100
No. 50	0.30 mm	10 - 100
No. 100	0.15 mm	0 - 20
No. 200	0.075 mm	0 - 5

2. The allowable amount of material passing a No. 200 sieve as determined by AASHTO - T11 or ASTM D422 shall not exceed 5 percent by weight.

2.05 CRUSHED STONE

A. Crushed Stone shall be composed of durable crushed rock consisting of angular fragments, free from a detrimental quantity of thin, flat, elongated pieces or shall be durable crushed gravel stone obtained by artificial crushing of gravel boulders or fieldstone. Crushed stone shall meet the specification for Underdrain Filter Type I materials, as specified in the NYSDOT Standard Specifications (Item 733.2001), as follows:

	Percent Passing by Weight
Sieve Size	
1 inch	100
1/2 inch	30-100
1/4 inch	0-30
No. 10	0-10
No. 20	0-5

B. Dense-graded Crushed Stone for Subbase and Base shall conform to the following gradation:

	Percent Passing by Weight
Sieve Size	2-inch Stone
2 inch	100
1-1/2 inch	70 - 100
3/4 inch	50 - 85
No. 4	30 - 55
No. 50	8 - 24
No. 200	3 - 10

C. Washed Crushed Stone for Stormwater Recharge shall be composed of durable crushed rock consisting of angular fragments, free from a detrimental quantity of thin, flat, elongated pieces or shall be durable crushed gravel stone obtained by artificial crushing of gravel boulders or fieldstone. The crushed stone shall be free from clay, loam, or deleterious material.

1. Washed Crushed Stone for Stormwater Recharge shall conform to the following gradation:

	Percent Passing by Weight	
Sieve Size	2-inch Stone	1-1/2 inch Stone
2 inch	90 – 100	100
1-1/2 inch	-	95 – 100
1-1/4 inch	25 - 50	45 – 80
1-inch	-	35 – 70
3/4 inch	0 - 15	0 – 25
1/2 inch	0 - 5	0 – 5
No. 4	0	0

2. AASHTO Designations:

	Percent Passing by Weight		
Sieve Size	No. 57	No. 3	No. 2
3 inch			100
2-1/2 inch		100	90-100
2 inch		90-100	35 - 70

1-1/2 inch	100	35-70	0 - 15
1 inch	95 - 100	0 - 15	0 - 5
½ inch	25 - 60	0 - 5	
No. 4	0 - 10		
No. 8	0 - 5		

D. Double-Washed Crushed Stone for Wastewater Soil Absorption Systems shall be composed of durable crushed rock consisting of angular fragments, free from a detrimental quantity of thin, flat, elongated pieces, or shall be durable crushed gravel stone obtained by artificial crushing of gravel boulders or fieldstone. The crushed stone shall be free from clay, loam, or deleterious material.

1. Double-Washed Crushed Stone for Wastewater Soil Absorption Systems shall conform to the following gradation:

	Percent Passing by Weight	
Sieve Size	1-1/2 inch Stone	½ inch Stone
2 inch	100	-
1-1/2 inch	95 - 100	-
1-1/4 inch	45 - 80	-
1-inch	35 - 70	-
3/4 inch	0 - 25	-
1/2 inch	0 - 5	100
3/8 inch	0	85 – 100
No. 4	-	15 – 45
No. 8	-	0 – 5
No. 40	-	0

2.06 STRUCTURAL FILL

A. Structural Fill shall be free from ice and snow, roots, sod, rubbish and other deleterious or organic matter. Structural Fill shall conform to the following gradation:

Sieve Size	Percent Passing by Weight
*	100
No. 4	30 - 95
No. 40	10 - 70
No. 200	0 – 15

* Two thirds (2/3) of the loose lift thickness.

2.07 STONE FILL

A. Stone Fill shall be hard, durable, clean, washed rock with a minimum diameter of 1-1/2 inches and a maximum diameter of 3 inches with void ratio of 30 to 40 percent.

2.08 RIPRAP

A. Revetment shall consist of slope protection of the required type at the location shown on the plans, and in conference with the lines and grades shown on the plans.

B. Riprap shall consist of a protective covering of angular shaped stones laid on slopes in front of structures, wingwalls, piers, and elsewhere as required, to insure protection of structures and embankments.

C. Riprap shall be sound, durable rock, which is angular in shape. Rounded stones, boulders, sandstone, or similar soft stone or relatively thin slabs will not be acceptable. Each stone shall weigh not less than 50 pounds and at least 75% of the volume shall consist of stones weighing not less than 500 pounds each. The remainder of the stones shall be so graded that when placed with the larger stones the entire mass will be compact.

2.09 STONE FOR PIPE ENDS

A. Stone for pipe ends and energy dissipaters shall be sound, durable rock, angular in shape. Rounded stones, boulders, sandstone, or similar stone or relatively thin slabs will not be acceptable. The majority of the larger stones shall weigh not less than 50 pounds nor be less than 1.4 ft. long, 0.5 ft. wide, and 0.5 ft. in height. Each larger stone shall weigh not more than 125 pounds nor be more than 2.0 ft. long, 0.8 ft. wide, and 0.8 ft. in height and at least 50 percent of the larger stone volume shall consist of stones weighing not less than 75 pounds nor be less than 1.6 ft. long, 0.6 ft. wide, and 0.6 ft. height. The remainder of the stones shall be so graded that when placed with the larger stones the entire mass will be compact.

2.10 SLOPE PAVING

A. Stone for slope paving shall be sound, angular, and free from structural defects. Each stone shall have one reasonably flat face and a thickness perpendicular to the face of not less than 6 inches, which shall be the least dimension of the stone.

B. Approximately 60 percent of the stones shall vary from 2 to 3 cubic feet each in volume and the remainder of the stones shall each be from 1 to 2 cubic feet in volume.

2.11 CHANNEL PAVING

A. Channel Paving and Grouted Channel Paving. Channel Paving of the type specified shall be placed as protective covering along the slopes around culvert inlets or outlets, around foundations, structure and dikes.

B. Stones for Channel Paving and Grouted Channel Paving shall be sound, angular blocks, as nearly rectangular or cubical as practicable. Rounded stones or relatively thin slabs will not be acceptable. At least 75 percent of the volume shall consist of stones weighing at least 200 pounds each. The remainder of the stones shall be so graded that when placed with the larger stones a compact mass will result.

2.12 FILTER FABRIC AND GEOTEXTILES

A. Filter Fabric used with riprap, stone for pipe ends, slope paving, or channel paving (grouted or ungrouted) shall be as Mirafi 600X or approved equivalent.

B. Filter Fabric used for prevention of soil intrusion into drains or to assist in stabilizing soil subgrades shall be Mirafi 140N or approved equivalent.

C. Filter fabric in drainage recharge systems, underdrain systems between crushed stone and granular soils, leaching areas, or where indicated on the plans shall be Mirafi 140N or approved equivalent.

2.13 STORMWATER EMBANKMENT FILL

A. Stormwater Embankment Fill shall be low permeability fill capable of being placed and compacted to provide an in-situ permeability rate of not more than 1.0×10^{-5} cm/sec.

2.14 CONTROLLED DENSITY FILL

A. Controlled low strength material or controlled density fill shall be a cement concrete backfill material that flows like a liquid, supports like a solid when cured, and levels without tamping or vibrating to reach 100 percent compaction. The material shall be used primarily as a backfill in lieu of compacted fill. The material shall be proportioned to yield a 28-day minimum compressive strength of 200 pounds per square inch. The material shall be produced and installed in accordance with ACI 229R-13, with a mix formulation to be approved by the Engineer or Geotechnical Consultant prior to placement of the material in the project.

2.15 LOAM BORROW

A. Loam borrow shall be fertile, friable soil obtained from naturally well-drained areas or shall be the product of a commercial sand and gravel processing facility. It shall be uncontaminated by salt water, foreign matter, or substances harmful to plant growth. Loam Borrow shall be free of debris rocks, clods, and any other extraneous matter greater than 2 inches (50 mm) in diameter.

B. Loam Borrow shall have the following mechanical analysis:

Sieve Size	Percent Passing
No. 10 (2 mm)	85-100
No. 40 (425 µm)	35-85
No. 200 (75 µm)	10-35
<20µm	0-5

C. Testing shall be on material that has passed the No. 10 sieve. Loam Borrow shall contain 4-10 percent organic matter as determined by the loss on ignition of oven-dried samples. Lawn areas shall have an organic content of at least 4 percent. Organic content for lawn areas shall be at least 4 percent; for woody plantings, organic content shall be 7-10 percent. Salinity (electrical conductivity) shall be less than 0.1 S/m as determined by a 1:2 (by volume) soil-to-water mix. Salt test samples shall not be oven-dried. The acidity range of the Loam Borrow shall be pH 5.5 to 7.0.

D. The Contractor shall provide testing submittals as follows:

1. One 25 pound (10 kg) representative sample per source of loam
2. For sources providing >1000 cubic yards, one additional 25-pound representative sample for each 1000 cubic yards unit of soil.

E. In addition, five random representative 25 pounds (10 kg) samples of on-site stockpiles of delivered loam shall be collected and packaged in the presence of the Engineer.

F. The Contractor shall deliver samples to testing laboratories and shall have the testing report sent directly to the Engineer.

G. Testing and analysis will be at the Contractor's expense. Soil samples shall be dry. Tests for particle gradation, organic content, and pH shall be performed by an Agricultural Experiment Station testing laboratory or other testing laboratory approved by the Engineer. Soil analysis tests shall show recommendations for soil additives to correct soils deficiencies, and for additives necessary to accomplish particular planting objectives noted.

H. No loam shall be delivered to the site until the review and approval of loam test results by the Engineer.

2.16 WETLAND SOILS AND ORGANIC MATERIALS

A. Natural Wetland Soils shall be obtained from nearby wetland impact areas. Only soils from the top 18-inches within designated wetland areas may be used as wetland soils in the wetland replication areas. Wetland soils may be highly organic in nature, such as a peat soil, or contain a high mineral content. Therefore, there is no specific standard for the composition of wetland soils. Wetland soils stripped from the wetland impact areas for use in the wetland replication areas shall be free of large stones, stumps, large sticks, shrubs or other litter.

B. Man-made Wetland Soils may be prepared by amending natural topsoil with peat moss or leaf mold, at a ratio of 75 percent soil to 25 percent organic material by volume. The resulting soil mix shall be free of large stones, stumps, large sticks, shrubs, or other litter.

C. Peat Moss shall be composed of the partly decomposed stems and leaves of any or several species of sphagnum moss. Peat moss shall be free from wood, decomposed colloidal residue and other foreign matter. Peat moss shall have a pH in the acidity range of 3.5 to 5.5, as determined in accordance with the testing methods of A.O.A.C., latest edition. The water absorbing ability of the peat moss shall be a minimum of 100 percent by weight on an oven-dry basis.

D. Leaf Mold shall be a highly organic dark brown to black spongy residue resulting from the well aerated composting of deciduous tree parts, free of plants and their roots, debris, and other extraneous matter and shall be uncontaminated by foreign matter and substances harmful to plant growth. The organic matter shall not be less than 85 percent by weight as determined by the loss on ignition of oven-dried samples. Test samples shall be oven-dried to a constant weight at a temperature of 16 degrees C. The inorganic residue after ignition shall not be finer textured than 4 percent by weight passing the number 200 sieve with washing.

2.17 BIORETENTION SOILS

A. Bioretention Soil shall be a loose uniform mix, free of stones, stumps, roots or other similar objects larger than two (2) inches in diameter, and without material toxic to plant growth.

B. The bioretention soil shall be free of noxious or invasive weeds including the following: Knotweed, Phragmites, Purple Loosestrife, Bermuda grass, Quackgrass, Johnson grass, Mugwort, Nutsedge, Poison Ivy, Canadian Thistle, or Tearthumb.

C. Bioretention soil may be manufactured using a blend of sand with amendment. Soils shall be 50% sand and 50% topsoil.

D. Bioretention facilities to be installed in accordance with “The New York State Stormwater Management Design Manual”.

E. Bioretention soil shall meet the following laboratory test parameters:

pH	5.2 – 7.0
Moisture Content	25% - 55%
Organic Matter Content	1.5% - 4% (dry weight basis)
Soluble Salts	Not to exceed 500 ppm
Magnesium	35 lb/acre
Phosphorus	75 lb/acre
Potassium	85 lb/acre
Infiltration Rate	2.0-4.0 in/hr

F. The bioretention soil shall meet the following mechanical analysis, as determined using ASTM D422 Standard Test Method for Particle-Size Analysis of Soils.

Textural Class	% of Total Weight
Gravel (greater than 2 mm)	< 15%
Sand (0.05 – 2.0 mm)	> 85%
Silt (0.002 – 0.05 mm)	< 10%
Clay (less than 0.002 mm)	< 5%

G. Permeability: Bioretention Soil shall have a minimum permeability of 2 inches per hour, as determined by ASTM D2434 Standard Test Method for Permeability of Granular Soils.

H. Soil Test Reports

1. Provide names and location of all sources of all compost, sand and other borrow suppliers, prior to ordering material. In addition, for bioretention soil mixture materials, submit soil test reports to the Representative for review and approval.
2. All compost shall be accompanied by certified laboratory capable of providing testing as specified herein.
3. Soil testing shall be incidental to the cost of this item. Submit Soil Test Reports accompanied by a one-pound representative sample of the soil at least one month before any soil spreading is scheduled. Contractor shall be responsible for timely procurement of results, including any costs for expedited testing.
4. Do not order materials until approval has been obtained. Delivered materials shall be from the same source as the tested material.
5. The Contractor shall employ a certified testing laboratory to test the material and shall submit test representative samples of bioretention soil mixture reports to the Representative. Reports shall include:
6. Tests for Phosphorus, Nitrogen, Potassium, Calcium, Soluble Salts, soil pH, Moisture Content, Organic Matter Content, and soil texture analysis in accordance with the current standards of the Association of Official Agriculture Chemists.
7. Test shall include a soil particle gradation analysis and permeability rate for the bioretention soil mixture.

PART 3 - EXECUTION

3.01 USE OF MATERIALS

A. Use of materials shall be as described below and as shown on the plans. Combinations or layering of materials may be necessary in certain instances such as for detention embankments, subsurface disposal areas, and riprap walls as examples.

1. Common/Ordinary Fill: Use common/ordinary fill for general grading as backfill, and as embankment fill in areas outside the building and pavement limits. Stones larger than twelve inches (12") shall be removed prior to compaction.
2. Gravel: Use for pipe bedding backfill and backfill below pavement and slab as base course layer. Use for material placed "in the wet". Use for backfill behind retaining walls and retaining structures. Use for pipe and utility bedding.
3. Sand: Use for conduit bedding and initial backfill, and gas line bedding and backfill. Use for bedding and backfill of direct burial cables and/or flexible piping. Use for bedding and filling joints for concrete unit pavers.
4. On-Site Disposal System Leaching Area Sand Fill Material: Fill or replacement material for on-site disposal system leaching areas and for wastewater disposal systems.
5. Crushed Stone: Use crushed stone as a filter material around perforated pipe and as bedding for piping under wet subgrade conditions.
6. Dense-Graded Crushed Stone: Use dense-graded crushed stone for subbase and base material.

7. Washed Crushed Stone: Use washed crushed stone in stormwater recharge system as the material around perforated pipe.
8. Double Washed 1-1/2 Inch Crushed Stone: Use double washed 1-1/2 inch crushed stone in soil absorption facilities for wastewater disposal systems, recharge filters, and as a filter material around perforated pipe.
9. Double Washed 1/2 Inch Crushed Stone: Use double washed 1/2-inch crushed stone in soil absorption facilities for wastewater disposal systems, recharge filters, and as a filter material around perforated pipe.
10. Structural Fill: Use structural fill below subgrade elevation in building areas such as beneath floor slabs, foundations, and in other soil bearing situations. Structural fill shall also be used for backfill against building foundations and frost walls. Use structural fills below pavement gravel base course.
11. Blast Rock Fill and Choke Stone: Blast rock fill may be placed to within forty-two (42") of finish grade in pavement and building floor slab areas, and to within eighteen inches (18") of utility line inverts and bottom of foundations. The first lift over the top of rock fill shall be a choke stone layer eighteen inches (18") thick. Compaction shall be by minimum of four (4) passes of a self-propelled vibratory drum roller in each direction (i.e., north-south and east-west). The minimum weight of the drum shall be ten thousand pounds (10,000 lbs.). Blast Rock shall not be placed within a five foot (5') horizontal distance on either side of proposed utility lines. The intent is to leave a zone of Structural Fill that can later be excavated for installation of utilities. Also, large rock fragments shall be kept away from utility pipes.
12. Filter Fabric: Filter Fabric is to be used as a filter barrier between drainage recharge systems, underdrain systems, wastewater absorption systems, and between natural earth material and backfill or other materials to assist in stabilizing soil subgrades.
13. Detention Basin Embankment Fill: Use a low permeability fill material in the core of detention embankments.
14. Riprap: Use riprap for slope stabilization and for erosion control in channel bottoms, overflow areas, level spreaders, and where otherwise indicated.
15. Stone for Pipe Ends: Use stone for erosion prevention at pipe ends of drainage pipes, energy dissipaters, stilling basins and at inlets to drainage structures.
16. Slope Paving: Use stone for slope paving to prevent slope de-stabilization, erosion, and to protect slope faces where indicated on the Drawings or where slopes of steeper than 2:1 are created due to site work.
17. Channel Paving and Grouted Channel Paving: Use stone for channel paving and grouted channel paving in and around watercourses to prevent erosion, scour, and instability of the channel bottom and side slopes.
18. Filter Stone Layer: Use filter stone layer under riprap, stone for pipe ends, slope paving, channel paving and grouted channel paving, or where indicated.
19. Controlled Low Strength Material or Controlled Density Fill: Shall be used for trench backfill, anti-flotation bases, and/or lightweight backfill.
20. Topsoil/Loam: Use as fill in designated landscape and lawn areas; if off-site material is required, Loam shall be furnished and installed. Topsoil maybe used as fill in landscape and lawn areas if an excess of topsoil exists on-site.
21. Wetland Soil/Organic Materials: Use a wetland soils in wetland replication areas.

3.02 EXCAVATION - GENERAL

A. General Definitions

1. Classification of Materials
   a. *Unclassified.* Unclassified excavation shall comprise and include the satisfactory removal and disposal of all materials encountered regardless of the nature of the materials, except for rock excavation and contaminated materials as defined below,

and shall be understood to include, but not be limited to, earth, hardpan, fill, foundations, pavements, curbs, piping, railroad track and ties, cobblestones, footings, bricks, concrete, abandoned drainage and utility structures, and debris.

b. *Rock Excavations.* Rock is defined for payment purposes as stone or hard shale in original ledge, boulders over two cubic yards (2 yd^3) in volume in open areas, and one cubic yard (1 yd^3) in volume in trenches, and masonry or concrete that cannot be broken or removed by normal job equipment (power shovels, scoops, or D-8 bulldozers with ripper attachment) without the use of explosives or drills. The classification does not include materials that can be removed by means other than drilling and blasting or drilling and wedging. Quantities shall be measured in their original position to the limits of clearly defined vertical construction lines and to the depth required for the defined construction. Payment will be at the unit prices stated in the Contract. Payment limit lines for rock excavation in trench will be 18 inches measured horizontally and 12 inches measured vertically below the pipe, duct bank or structure. Pay limit lines for open rock excavation will be measured 12 inches below the bottom of normal excavation limits.

c. The Contractor shall immediately halt soil movement activities and notify the Owner if visual, olfactory, or other evidence suggests that soils may be contaminated with oil or hazardous materials. Contractor shall provide reasonable assistance to Owner and to Owner's Representative for access to potential contamination areas for proper assessment of hazardous conditions.

d. The Owner will contact an environmental professional (such as a Licensed Site Professional) to test any earth materials suspected of containing hazardous waste. Owner will inform the Contractor of the laboratory test results as soon as possible and discuss the possible soil management, disposal, and recycling options available. Contaminated soils shall be managed and handled in compliance with the referenced state & federal regulations, guidelines, and policies. Time and expenses associated with contaminated soils shall be negotiated between the Contractor and the Owner prior to the start of the soil management, soil disposal, and recycling work. Owner reserves the right to negotiate and contract with other entities for remedial work and, in that event, this Contractor shall make reasonable accommodations for other entities to perform this work.

e. Although there is no evidence of oil or hazardous material, there is a possibility of the presence of such wastes on this site. Appropriate testing, as recommended by an environmental professional shall be accomplished to assess the potential presence of oil or hazardous material. Earth material shall not be removed from the site unless on-site reuse is not possible.

f. Proper documentation of legal disposal of hazardous materials handled by this Contractor shall be provided by the Contractor to the Owner, Engineer, and review authorities.

g. Unless specifically identified as contaminated material under referenced statues and as defined above, as judged by the Engineer, excavated materials shall be considered unclassified as defined in Item 1., above.

B. Site General Requirements

1. Control the grading so that ground is pitched to prevent water from running to excavated areas, damaging other structures, or adjacent properties.
2. Where soil has been softened or eroded by flooding, equipment, traffic, or placement during unfavorable weather, or other conditions, it shall be removed and replaced by the Contractor with suitable material, and at no cost to the Owner.
3. Exercise care to preserve the material below and beyond the lines of excavation. Where excavation is carried out below indicated grade or beyond the lines of excavation,

Contractor shall backfill and compact the over excavation with structural fill to the indicated grade, at no additional cost to the Owner and at the direction of the Engineer.

4. Provide sheeting, shoring and bracing to complete and protect all excavated areas, as required for safety and compliance with OSHA. Costs for sheeting, shoring, and bracing shall be included as a part of the Contract Price for completing the work and Owner will make no separate payment for this work.
5. Excavated materials unsuitable for reuse, surplus excavated rock, and surplus excavated soil not used to fulfill requirements of the Contract, shall become the property of the Contractor and shall be removed from the site in accordance with the regulations and requirements of all municipalities or agencies having jurisdiction over the disposal sites and the route between the project and the disposal sites.
6. Limits of excavation shall be such that all unsuitable material shall be removed to firm natural ground in the manner specified below:
    a. In building areas, unsuitable materials shall be removed to a distance of five feet (5') beyond the building lines or within the area defined by a one horizontal to one vertical (1h:1v) line sloping down from outside bottom edge of exterior footings to firm natural ground, whichever is greater.
    b. Limits of unsuitable material excavation also apply to areas below exterior column footings.
    c. All abandoned pipes within building areas shall be removed and the excavations shall be properly backfilled.
7. Unsuitable materials which are classified as organics such as peat, trash, fill, stumps, debris, material determined to be hazardous, and topsoil and subsoil when determined by Engineer to be unacceptable for incorporation into the work.
8. Under pavement areas, existing fill shall be densified in place and shall not be excavated.
9. When approved by Engineer, topsoil will not need to be excavated from pavement areas if located more than three feet (3') below finish pavement grades.
10. Suitable material, as determined by the Engineer, may be reused on the site provided it meets the gradation requirements for the given materials as specified under 2.0 MATERIALS.
11. The Contractor shall not over-excavate below proposed design grades for the purpose of obtaining borrow for use off-site.

C. Proof Rolling

1. Prior to placing compacted fills, the Contractor shall proof roll the natural grades to remain. Where materials of low density are indicated by rutting or weaving under the compactor, the Contractor may be required to make up to three (3) additional complete passes of the area with the compactor as determined by the Engineer. The cost of all proof rolling shall be included in the Contract Price. If materials of low density are encountered that cannot be compacted to the extent necessary to support the proposed embankment fills as determined by the Engineer, the Contractor shall remove those materials and replace them with compacted fill.
2. Alternately, an initial layer of fill may be allowed to form a working platform. The need, manner of construction, and thickness of such a layer shall be subject to approval of the Engineer and the layer will be permitted only where the lack of support is, as determined by the Engineer, not due to deficient ditching, grading or drainage practices, or where the embankment could be constructed in the approved manner by the use of different equipment or procedures. Thickness of up to eighteen inches (18") may be permitted for such a layer.

3.04 SHEETING SHORING AND BRACING

A. General

1. Whenever sheeting, shoring, and bracing will be required, it shall be furnished and installed by the Contractor in accordance with State and Federal guidelines, regulations and the recommendations of the structural engineer and/or geotechnical engineer engaged by the Contractor.
2. When required, the Contractor shall engage licensed professional structural engineer and/or geotechnical engineer to design sheeting, shoring, and bracing. These engineers shall be licensed in the state where the work is occurring and they shall prepare designs for the sheeting and bracing.
3. Submit the sheeting and bracing designs to the Owner and the Engineer for the project record. The sheeting and bracing plans and calculations shall bear the professional seals and signatures of the Contractor's engineers. These plans and calculations shall be submitted prior to the start of work.
4. The Contractor shall furnish and install the required sheeting, shoring and bracing in accord with the submitted designs. The Contractor shall include the costs for this work in his bid price for the project. No additional or separate compensation will be allowed.

3.05 TRENCH EXCAVATION

A. Excavate as necessary for all drainage pipes, utilities, and related structures and appurtenances, and for any other trenching necessary to complete the work.

B. Definitions:

1. Trench shall be defined as an excavation of any length where the width is less than twice the depth and where the shortest distance between payment lines does not exceed ten feet (10'). All other excavations shall be defined as open excavations.
2. The words "invert" or "invert elevation" as used herein shall be defined as the elevation at the inside bottom surface of the pipe or channel.
3. The words "bottom of the pipe" as used herein shall be defined as the base of the pipe at its outer surface.

C. In general, machine excavation of trenches will be permitted with the exception of preparation of pipe beds which will be hand work. Excavate by hand or machine methods to at least six inches (6") below the bottom of pipe or as shown on the Drawings. Excavation to final grade shall be made in such a manner as to maintain the undisturbed bearing character of the soils exposed at the excavation level.

D. Utilities or piping shall not be laid directly on boulders, cobbles, or other hard material. This material shall be removed to a minimum of six inches (6") below the bottom of pipe at all points and backfilled or compacted as specified.

E. Remove unsuitable material encountered at subgrade elevations, backfill with material specified herein and as otherwise indicated on the Drawings, specified, or directed. Compact as specified with approved compactors.

F. In general, the width of trenches shall be kept to a minimum and in the case of piping shall not exceed the sum of the pipe's outside diameter plus 2'-0" to at least twelve inches (12") above the pipe.

3.06 ROCK EXCAVATION

A. Definitions

1. Rock is defined for payment purposes as stone or hard shale in original ledge, boulders over two cubic yards (2 yd^3) in volume in open areas, and one cubic yard (1 yd^3) in volume in trenches, and masonry or concrete that cannot be broken or removed by normal job equipment (power shovels or track mounted excavator without the use of explosives or drills.
2. The definition does not include materials that can be removed by means other than drilling and blasting or drilling and wedging.

B. General

1. When rock is encountered, such material shall be removed to the clearance limits set forth in these Specifications.
2. Payment for rock excavation shall be made in accordance with Item 3.03A.1.
3. Rock excavation shall be performed to eliminate water pockets in the excavated rock subgrade. Contractor shall provide dewatering as required to keep the excavated rock subgrade dry until earthwork operations are complete.

C. Cross-Sectioning and Measurement

1. When rock is encountered, the rock shall be uncovered and exposed, and the Engineer shall be notified in writing by the Contractor before blasting work proceeds. Quantities shall be based on measurements of rock in their original position and to the limits of clearly defined vertical and horizontal construction lines required for the defined construction.
2. The rock shall then be measured, quantities established, and payment amounts determined.
3. Excavation of material in question before agreement by the Engineer as to the character of the material, or failure to notify the Engineer, or failure to take measurements will forfeit the Contractor's right to payment for rock excavation.
4. The quantity of rock to be removed shall be based on the limits established under the Clearance Limits specified below.
5. Measurements shall be made by a registered surveyor, paid for by the Contractor and approved by the Engineer.
6. Cross-sectioning and measuring shall not be required when the payment for rock excavation is included as a part of the lump sum Contract Price.

D. Clearance Limits

1. Foundations and Slabs: Within the limits of the concrete lines as defined by the working plans or as otherwise approved by the Engineer, plus twelve inches (12") outside the vertical concrete lines and twelve inches (12") below base.
2. Utility Trenches: All parts of pipe, valves, and fittings to a depth of six inches (6") below the bottom of the bell and for a width equal to the outside diameter of the pipe, plus fifteen inches (15") beyond the outside diameter on each side, provided that overlapping computed volumes of any ledge or boulder excavation shall be paid for only once.
3. Paved Areas: To the underside of the subbase.
4. Site Structures: Twelve inches (12") outside of structure all around.
5. Lawn areas and shrub planting areas: To a depth of eighteen inches (18") below finished grade.
6. Planting areas for trees over two inches (2") in caliber size: To depth of thirty-six inches (36") below finished grade and for a radius of 3 feet (3') around each tree, except volumes in radius areas shall not overlap.
7. Any foreseen rock or boulder encountered, as defined above, which must be removed for construction of the work defined on the plans or in modification thereto, shall be measured in its original position to the limits of clearly defined vertical construction lines and to the depth required for the defined construction.

E. Reuse of Excavated Rock

1. Riprap
   a. Excavated rock may be used as riprap, for construction of stone masonry walls, and for sloped riprap for retaining walls, provided that the rock is judged to be adequate quality by the Owner's Representative and the rock is sufficiently broken to meet gradation requirements established for the intended use.
2. Fills
   a. Reuse of excavated rock for fill materials shall require prior approval of the Owner's Representative and shall require compliance with gradation requirements for the specific type of fill for which it is being used.

F. Rock Subgrades under Building Footings and Paved Areas

1. Excavation of rock under footings and paved areas shall include the removal of all loose material to the top of sound bedrock that is acceptable to the Owner's Representative. Sound bedrock is defined as hard, intact rock that cannot be excavated with a track mounted excavator.
2. Rock surface for footings shall have a maximum slope of four (4) horizontal to one (1) vertical.
3. Rock excavations for footings carried below design grades shall be backfilled by placement of concrete with same strength as footing at the Contractor's cost. At the discretion of the Structural Engineer of Record (SER), footings could be dropped below design elevation onto competent rock.

3.07 PREPARATION OF EXCAVATION BOTTOMS

A. General Rock Subgrade Areas

1. Rock surfaces to receive backfill shall have a maximum slope of four (4) horizontal to one (1) vertical.

B. Building and Pavement Areas

1. Loose rock is covered with 6 inches (6") of crushed stone or choke stone; and
2. Prior to placing crushed or choked stone, the area is rolled with a heavy vibratory roller Or fully loaded ten wheel dump truck.
3. Proof-roll subgrade with a vibratory roller or a fully loaded ten-wheeled dump truck. Soft or hard areas and other objectionable material (stumps, wood, organics) shall be excavated and backfilled with compacted structural fill.
4. Prior to the placement of blast rock fill over a bedrock subgrade, voids in the rock surface shall be choked off with appropriately graded choke stone or crushed stone to prevent migration of fines into fractures, and as approved by the Owner's Representative.

C. Subgrades under Proposed Landscape Areas

1. Depth to rock under planting areas shall be a minimum of 48 inches (48") below subgrade elevations. Backfill up to subgrade shall be done with topsoil/loam materials.
2. In lawn areas, scarify subsoil a minimum depth of six inches (6"). Subsoil shall also be cleared of debris and stones larger than four inches (4") prior to topsoil spreading.
3. In planting areas, scarify subsoil a minimum depth of six inches (6") below the required root ball excavation prior to placement of plant backfill mixture.

D. Trenches

1. Compaction equipment used in open areas where space permits shall consist of vibratory rollers, fully loaded ten-wheel dump trucks, pneumatic compactors, or other similar equipment.
2. Compaction equipment for fill against foundation walls and in other confined areas shall be accomplished by means of drum-type, power-driven, hand-guided vibratory compactors operating at 2,000 cycles per minute, or by hand-guided vibratory plate tampers.

3.08 BACKFILLING AND PLACEMENT OF FILL MATERIALS

A. Site

1. Dewater subgrade areas prior to filling.
2. Compaction by puddling or jetting is prohibited.
3. Control groundwater and surface runoff to minimize disturbance of exposed natural ground surface, previously placed and compacted fill and material being placed.
4. Soil fill moisture shall be maintained at an acceptable working range to allow for proper compaction.
5. Do not place fill on frozen ground.
6. Do not place frozen fill.
7. Place fill in uniform horizontal layers and compact immediately after placement. Where the horizontal layer meets a rising slope, the layer shall be keyed into the slope by cutting a bench during spreading of preceding lift.
8. To the extent that is practical, each layer of fill shall be compacted to the specific density the same day it is placed.
9. Slope fill surfaces at the end of each day to provide for free surface drainage.
10. Protect structures and pipes from damage during backfilling operations. Repair damage at no cost to Owner.
11. Placement of fill shall not begin prior to observation and approval of subgrade conditions by Engineer.
12. Protect foundations, footings, and waterproofing during backfilling. Repair damage at no cost to Owner.
13. Prior to backfilling between foundation wall and sheeting, remove unsuitable material, including rubbish, organic materials, or other debris. Do not commence filling operations until conditions have been observed by Engineer.
14. Backfill shall not be placed against walls until they are braced or have cured sufficiently to develop strength necessary to withstand, without damage, pressure from backfilling and compacting operations.
15. Provide shoring, sheeting, and bracing of excavations as required to assure complete safety against collapse of the earth at the site of excavations. Alternatively, lay back excavations to suitable slope.
16. Upon completion of the work, the final ground surface shall be left in a firm, unyielding, true, uniform condition free from ruts. Repair disturbed areas caused equipment traffic at no cost to Owner.

B. Equipment

1. Compaction equipment used in open areas where space permits shall consist of vibratory rollers, fully loaded ten-wheel dump trucks, pneumatic compactors, or other similar equipment.
2. Compaction equipment for fill against foundation walls and in other confined areas shall be accomplished by means of drum-type, power-driven, hand-guided vibratory compactors operating at 2,000 cycles per minute, or by hand-guided vibratory plate tampers.

C. Blast Rock Backfill – Structure and Foundation Backfilling and Compacting

1. Prior to the placement of blast rock fill over a bedrock subgrade, voids in the bedrock surface shall be choked off with appropriately graded crushed stone or choke stone to prevent migration of fines into fractures as approved by the Owner's Representative.
2. Blast rock fill and crushed stone shall be placed and compacted as indicated below:
   a. Maximum lift thickness prior to compaction shall be 24 inches (24").
   b. Material shall be dumped 25 feet behind the fill face and pushed forward to allow mixing and removal of oversized rock and backfilling voids.
   c. Should the maximum size of blast rock exceed 18 inches (18"), then use a rock rake with teeth spaced at 18 inches (18"), or other means to separate and remove oversized rock.
   d. Provide a minimum of 18-inch-thick transition zone of choke stone between blast rock fill and granular fill materials. All blast rock fill shall be choked with a transition zone of choke stone, where structural fill is to be placed above or adjacent to it.
   e. Compact each lift of blast rock fill with a vibratory drum roller or fully loaded ten-wheel dump truck.
   f. Crushed stone and choke stone placement shall not exceed a maximum lift thickness of 12 inches (12") prior to compaction.

D. Placing Fill

1. Fill sections and embankments shall be constructed of earth, rock, or a mixture of earth and rock deposited in successive lifts. Except as hereinafter permitted, the loose thickness of each lift shall not be more than twelve inches (12") before compaction.
2. Rock fill may be used in deep fill areas, placed to the levels and under the conditions described in Section 2.01K.
3. No rock in excess of six inches (6") in its largest dimension shall be incorporated in the top two foot (2') layer of embankment immediately below the subgrade.
4. During fill and embankment construction operations, earth moving equipment shall be routed as evenly as possible over the entire width of the work.
5. At the close of each day's work the working surface shall be crowned, shaped, and rolled with smooth steel or pneumatic tired rollers to ensure proper drainage.
6. Prior to placing compacted structural fill below the slab, the surface of natural ground, shall be proof-rolled with a heavy vibratory drum roller or a fully loaded ten-wheel dump truck. Hard and soft spots shall be excavated and replaced with structural fill or other material acceptable to the Owner's Representative.
7. Where excavations for slab-on-grade extend to weathered fractured or blasted bedrock, the Owner's Representative shall assess the rock surface for the presence of voids and may require placement of a 2 inch to 18-inch layer of choke stone or crushed stone prior to placement of structural fill.

E. Fills under Parking Areas

1. Paved area subgrades shall be excavated to a minimum of 12 inches (12") beneath required subgrade elevation or existing grade, whichever is lower.
2. Proof-roll subgrade with a vibratory roller or a fully loaded ten-wheeled dump truck. Soft or hard areas and other objectionable material (stumps, wood, organics) shall be excavated and backfilled with compacted common fill.
3. Where excavations for pavements extend to weathered, fractured, or blasted bedrock, prepare surface as indicated in Section 3.05B. for building and pavement areas.
4. A minimum of 12 inches (12") of gravel base course shall be provided between subgrade and the bottom of the bituminous surface.

F. Subgrades under Proposed Landscape Areas

1. Fills under tree and shrub planting areas shall be backfilled with topsoil/loam materials.

G. Buildings

1. Prior to the placement of blast rock fill over a bedrock subgrade, voids in the rock surface shall be choked off with appropriately graded choke stone or crushed stone to prevent migration of fines into fractures, as approved by the Owner's Representative.
   a. Blast rock fill and crushed stone shall be placed and compacted as indicated below.
2. Blast Rock Fill Placement and Compaction:
   a. Maximum lift thickness prior to compaction shall be 24 inches (24").
   b. Material shall be dumped 25 feet behind the fill face and pushed forward to allow mixing and removal of oversized rock and backfilling voids.
   c. Should the maximum size of blast rock exceed 18 in., (18") then use a rock rake with teeth spaced at 18 in. (18") or other means to separate and remove oversized rock.
   d. Provide a minimum of one-foot thick transition zone of crushed stone between blast rock fill and granular fill. All blast rock fill shall be choked with a transition zone of crushed stone, where granular fill is to be placed above it.
   e. Compact each lift of blast rock fill with a vibratory drum roller or a fully loaded ten-wheel dump truck.
3. Crushed Stone Placement and Compaction:
   a. Maximum lift thickness prior to compaction shall be 12 in. (12").
4. Structural Fill: A minimum of 24 inches (24") of compacted structural fill shall be placed in maximum 12-inch (12") lifts immediately below the slabs.

H. Revetments

1. General
   a. Areas to be protected by revetment shall be free of brush, trees, stumps, and other organic material and be dressed to a smooth surface. All soft or spongy material shall be removed to the depth shown on the plans or as directed by the Engineer and replaced with approved materials.
   b. A toe trench shall be dug and maintained until the revetment is placed.
   c. Protection for structure foundations shall be provided as early as the foundation construction permits.
   d. The area to be protected shall be cleaned of waste materials and the surface to be protected shall be prepared as shown on the plans.
   e. Where shown on the plans, a foundation filter bed shall be placed on the area before the stone is placed. The foundation filter bed will be six inches (6") of dense graded crushed stone and six inches (6") of one-half inch crushed stone and at least 12 inches (12") in total thickness.
2. Riprap
   a. The stones shall be placed upon an approved filter bed to the lines and grades shown on the plans and as directed.
   b. Each stone shall be carefully placed, by hand or machine as required, on a prepared bed, normal to the slope and firmly bedded thereon.
   c. The larger stone shall be placed closely together and the intervening spaces filled with smaller stones in such a manner that the entire surface will form a compact mass.
3. Stone for Pipe Ends
   a. Stone for pipe ends shall consist of a protective covering of angular shaped stones laid on slopes in front of and around drainage line ends or structures to insure protection of the pipe ends and the embankment and shall conform to the requirements for “Stone for Pipe Ends."
   b. The stone shall be placed to line and grade as shown on the plans or as directed on a prepared bed of embankment material or existing materials. Each stone shall be

carefully placed by hand, normal to the slope and firmly bedded thereon. The larger stones shall be placed directly at the drainage end to prevent erosion and displacement. Each stone shall weigh not less than the minimum specified nor more than the maximum specified and at least 75 percent of the volume shall consist of stones weighing not less than the d_{50} Median. The remainder of the stones shall be so graded that when placed with the larger stones, the entire mass will be compact with a minimum number of voids and a minimum thickness of 9 inches (9").

4. Slope Paving
   a. The stones shall be placed upon an approved filter bed to the lines and grades shown on the plans and as directed. The larger stones shall be placed closely together throughout the surface and the interstices carefully chinked with smaller stones. All stones shall be securely bedded, with the exposed surfaces approximately parallel to and within 6 inches (6") of the slope shown on the plans. When the paving cannot be laid to the required line and grade below water, a suitable foundation of dumped riprap shall be constructed.
5. Channel Paving and Grouted Channel Paving
   a. All stones shall be placed upon an approved bed to the lines and grades shown on the plans and as directed. The larger stones shall be placed as closely together as possible throughout the surface. All stones shall be securely bedded and laid so that the exposed surfaces will be approximately parallel to and within a tolerance of 3 inches (3") of the grade shown on the plans. The finished paving shall present a continuous uniform surface of stone.
   b. Grouting, when required, shall be done after the paving is completely in-place. The paving stones shall be sprinkled with water immediately before placing the grout.

3.09 TRENCH BACKFILL

A. General

1. Trenches shall be backfilled as soon as practicable with suitable approved materials. All trench backfilling shall be done with special care, in the following manner and as the Engineer may direct from time to time.
2. Backfill material for pipe bedding shall be deposited in the trench, uniformly on both sides of the pipe, for the entire width of the trench to the spring-line of the pipe. The backfill material shall be placed by hand shovels in layers not more than 6 inches (6") thick in loose depth and each layer shall be thoroughly and evenly compacted by tamping on each side of the pipe to provide uniform support around the pipe.
3. Trench backfilling shall be placed so as not to disturb the previously installed pipes, utilities, concrete, and other work within and near the trench. The moisture content of the backfill material shall be such that proper compaction will be obtained. Backfill of trenches within areas of pavement construction shall be made in controlled compacted lifts extending to grades required to establish the proper pavement base courses.
4. In backfilling trenches, each layer of backfill material shall be adequately compacted in such a manner as to provide the required bearing value, so that paving can proceed immediately after backfilling is completed.
5. Any trenches or excavations improperly backfilled, or where settlement occurs, shall be reopened to the depth required for proper compaction, then refilled and compacted with the surface restored to the required grade and condition, at no additional cost to the Owner.
6. During filling and backfilling operations, pipelines will be checked to determine whether any displacement of the pipe has occurred. If the inspection of the pipelines shows poor alignment, displacement of pipe, or any other defects, the condition shall be remedied by removal, realignment, and backfill of the pipe, in a manner satisfactory to the Engineer at no additional cost to the Owner.

B. Embedment

1. The type of materials to be used in bedding and backfilling shall conform to the details shown on the Drawings and the following:1. Embedment materials are those used for bedding, haunching and initial backfill. Perform in accordance with ASTM D2321. The following will describe the soils:
   a. Class I - Angular crushed stone or rock, dense or open graded with little or no fines (3/4-inch stone size) (to be used in wet conditions or where shown on the Drawings).
   b. Class II - Clean, coarse grained gravel, with a maximum stone size of 1-1/2 inches.
   c. Embedment materials shall be free from lumps of frozen soil or ice when placed. Embedment materials shall be placed and compacted at optimum moisture content.
2. Foundation: A stable utility foundation of Class I or II material must be provided to insure proper line and grade is maintained. Unsuitable foundations such as organics, soft clay, and other soft materials must be removed and the material stabilized. Unsuitable or unstable foundation materials shall be undercut and replaced with a suitable bedding material of Class I or Class II (see 3.08B.5.), placed in 6-inch (6") lifts. The Engineer may approve other methods of stabilization, such as the use of geotextiles.
3. Bedding: Provide a stable and uniform bedding for the pipe and any protruding features of its joints and/or fittings. The bedding for the middle 1/3 of the pipe outside diameter should be loosely placed so that the pipe conforms to the trench. The remainder of the bedding at the base of the trench shall be compacted to a minimum of 95 percent modified proctor density as determined by ASTM D1557. Class I or Class II materials are suitable for use as bedding.
4. Haunching: Proper haunching provides a major portion of the pipe's strength and stability. Care must be exercised to insure placement and compaction of the embedment material in the haunches. For larger diameter pipes (greater than 30" in diameter), embedment materials should be worked under the haunches by hand. Haunching materials may be Class I or Class II materials and shall be placed and compacted in 6-inch (6") maximum lifts, compacted to 95 percent modified proctor density.
5. Initial Backfill: Initial backfill materials are required for a minimum of 3/4 of the pipe diameter. The initial backfill shall be from the pipe’s springline to 12 inches above the pipe to provide protection for the pipe from construction operations during placement of the final backfill and protect the pipe from stones or cobbles in the final backfill.
   a. Class I materials must be used in wet trenches and Class I bedding and haunching materials shall be used.
   b. Class II materials shall be used unless noted otherwise or wet conditions are encountered. The material shall be compacted in 6 inch (6") lifts to 95 percent modified proctor density (ASTM D1557).
   c. Flooding or jetting as a procedure for compaction are not allowed.
6. Controlled Low Strength Materials (CLSM) or Controlled Density Fill (flowable fills) are acceptable backfill materials. Several considerations should be accounted for when using CLSM/CDF backfill. Provisions to prevent flotation of the pipe during placement of the CLSM/CDF must be used. This can include anchoring the pipe by placing flowable fill at the each joint and allowing the fill to partially cure prior to placing the flowable fill along the entire length of the pipe. Also, mechanical anchors such as bent rebar driven into competent soil or precast weights may be used at each joint to prevent flotation. When using CLSM/CDF, the fill should always be placed to completely encase the pipe.
7. Backfill. Backfill from one foot (two feet for HDPE pipe) above the top of the pipe to subgrade elevations shall be structural fill material. Generally, the excavated trench material may be used as this backfill. This backfill shall be placed in 12-inch (12") maximum lifts and compacted to a minimum of 92 percent modified proctor density to prevent excessive settlement at the surface.

8. Vehicular and Construction Loads: Pipe installation shall be suitable to carry H-25 live loads (40,000 lbs. axle - legal load) with 24 inches (24") of cover.

3.10 BACKFILL AGAINST STRUCTURES

A. Backfilling against masonry or concrete shall only be done when approved. The Contractor shall not place backfill against or on structures until they have attained sufficient strength to support the loads (including construction loads) to which they will be subjected, without distortion, cracking or other damage. As soon as practicable after the structures are structurally adequate and other necessary work has been satisfactorily completed, any leakage tests or other testing of the structures shall be made by the Contractor, as required by the Engineer, at the Contractor's expense.

1. After the satisfactory completion of leakage tests and the satisfactory completion of any other required work in connection with the structures, the backfilling around the structures shall proceed using suitable and approved excavation material. The best of the backfill material shall be used for backfilling within 2 feet (2') of the structure. Just prior to placing backfill, the areas shall be cleaned of all excess construction material and debris and the bottom of excavations shall be in a thoroughly compacted condition.

B. Symmetrical backfill loading shall be maintained. Special care shall be taken to prevent any wedging action or eccentric loading upon or against the structures.

1. During backfilling operations, care shall be exercised that the equipment used will not overload the structures in passing over and compacting these fills. Except as otherwise specified or directed, backfill shall be placed in layers not more than 12 inches (12") in loose depth and each layer of backfill shall be compacted thoroughly and evenly using approved types of mechanical equipment. Each pass of the equipment shall cover the entire area of each layer of backfill.

C. In compacting and other operations, the Contractor shall conduct his operations in a manner to prevent damage to structures due to passage of heavy equipment over and adjacent to structures. Repair damage made by the Contractor, at no additional cost to the Owner.

D. After backfilling the Contractor shall maintain the surfaces of backfill areas in good condition so as to present a smooth surface at all times level with adjacent surfaces. The Contractor shall repair any subsequent settling over backfilled areas immediately, in a manner satisfactory to the Engineer, and such maintenance shall be provided by the Contractor for the life of this Contract, at no additional cost to the Owner.

E. The finished subgrade of the filled excavations upon which pavements are to be constructed shall not be disturbed by traffic of other operations and shall be maintained in a satisfactory condition until the finished courses are placed. The storage or stockpiling of materials on finished subgrade will not be permitted.

F. Uniformly smooth grade all areas to be graded, as indicated including excavated sections and all areas disturbed as a result of the Contractor's operations. The finished surfaces shall be reasonably smooth, compacted and free from surface irregularities.

3.11 COMPACTION

A. Compaction Requirements

1. The degree of compaction is expressed as a percentage of the maximum dry density at optimum moisture content as determined by ASTM D1557, Method C. The compaction requirements are as follows:

Area of Compaction	Minimum Degree
Below footings	95%
Below slabs	95%
Detention basin berms	95%
Pavement base course	95%
Pavement subbase	95%
General fill below pavement subbase	90%
Trench backfill	92%
Lawn areas	90%

2. Compaction percentages are based on the laboratory derived Maximum Density Values.

B. Moisture Control

1. Fill that is too wet for proper compaction shall be harrowed or otherwise dried to a proper moisture content to allow compaction to the required density. If fill cannot be dried within 24 hours of placement, it shall be removed and replaced with drier fill.
2. Fill that is too dry for proper compaction shall receive water uniformly applied over the surface of the loose layer. Sufficient water shall be added to allow compaction to the required density.
3. In no case shall fill be placed over material that is frozen. No fill material shall be placed, spread, or rolled during unfavorable weather conditions. When work is interrupted by heavy rains, fill operations shall not be resumed until the moisture content and the density of the previously placed fill are as specified.

C. Lift Thickness of Material

1. Structural Fill and Sand Borrow. Place in layers not to exceed 12 inches (12") in thickness when utilizing heavy compaction equipment, and 6 inches (6") when utilizing light hand-operated compaction equipment.
2. Common Fill. Place in layers not to exceed 12 inches (12") in thickness when utilizing heavy compaction equipment, and 8 inches (8") when utilizing light hand-operated compaction equipment.
3. Crushed Stone, Gravel, Dense, Graded Crushed Stone for Subbase. Place in layers not to exceed 9 inches (9") in thickness when utilizing heavy compaction equipment, and 6 inches (6") when utilizing light hand-operated compacted equipment. Compact with a minimum of four (4) coverages of acceptable compaction equipment.

3.13 PROTECTION OF FILL

A. Protection of compacted fill shall be the responsibility of the Contractor. Newly graded areas shall be protected from the actions of the elements and traffic. Any settlement or washing that occurs prior to acceptance of the work shall be repaired and grades shall be established to the required elevations and slopes. Damage to any compacted lift (including those lifts previously tested and approved by the Engineer) occurring at any time during the course of construction, which is caused by equipment, moisture entering the embankment, or from any other cause, shall be fully repaired by the Contractor prior to placement of overlying materials, at no additional cost to Owner and to the complete satisfaction of the Engineer.

B. In the event of and prior to the commencement of heavy rains, the Contractor shall suspend fill operations immediately and shall take all necessary steps to keep the site as well drained as possible. Fill operations shall not be resumed until the moisture content of the fill is such as to permit compliance with the Specifications.

C. All corrective work or operations necessary to maintain proper moisture control of the fill material shall be at the expense of the Contractor.

3.14 GRADING TOLERANCES

A. Grading shall be completed to meet or exceed the following tolerances of uniformity*:

Location	Tolerance
Top of Subgrade Beneath Structures	1/2 inch
Top of Subgrade Beneath Paving	1/2 inch
Top of Subgrade Beneath Landscape Areas	1 inches
Top of Gravel and Gravel Bases	1/4 inch

* Uniformity is defined as no variations in the surface materials at the grades and slopes indicated on the Drawings that exceed the listed tolerance over a length of ten feet (10') horizontally in any direction.

END OF SECTION 310000

SECTION 311000
SITE CLEARING

PART 1 – GENERAL

1.01 DESCRIPTION

A. This Section specifies requirements for site clearing including demolition of site structures.

B. The work includes:

1. Protection of existing vegetation to remain
2. Clearing and grubbing
3. Selective clearing and thinning
4. Site demolition of structures, retaining walls, signage, light standards, foundations and appurtenances
5. Removal and abandonment of utilities
6. Filling or removal of underground tanks and piping
7. Disposal of material from clearing, grubbing, thinning and demolition in approved off-site disposal areas
8. Filling of voids and excavations resulting from the work

1.02 RELATED SECTIONS

A. Other Specification Sections which directly relate to the work of this Section include but are not limited to:

1. Section 312500 – EROSION AND SEDIMENTATION CONTROLS
2. Section 310000 – EARTHWORK

1.03 SITE CONDITIONS

A. Site conditions existing during the bidding period will be maintained by the Owner insofar as practical.

B. Actual site condition variations that differ from those of the bidding period and which affect site clearing operations shall be brought to the attention of the Owner prior to the commencement of any site work.

1.04 Laws and Regulations

A. Compliance with the NYSDEC SPDES General Permit for Stormwater Discharges from Construction Activity, Permit No. GP-0-20-001 and referenced documents.

1.05 SUBMITTALS

A. The Contractor shall submit the following information to the Engineer for review before commencing work:

1. All permits and notices authorizing site clearing and demolition
2. Certificates of utility service severances
3. Permits for transport and disposal of debris
4. Demolition procedures and operational sequence
5. Calculations

PART 2 - PRODUCTS

2.01 TREE PROTECTION FENCING

A. Tree protection fencing shall be an orange plastic web fence, 4 feet high minimum. Wood stakes shall be six (6) foot long by 1 inch by 1 inch square driven a minimum of two (2) feet into the ground. Posts shall be spaced eight (8) feet on center, maximum.

PART 3 - EXECUTION

3.01 PROTECTION

A. The Contractor shall flag the limits of clearing shown on the drawings by accurate field survey with marked stakes or other means acceptable to the Engineer. Trees to remain and trees to be saved and transplanted shall be clearly identified during this staking process. The Engineer shall be notified a minimum of five (5) working days prior to scheduled commencement of clearing operations to review the flagged limits. Adjust the clearing limits as directed by the Engineer.

B. Before clearing begins, protect designated trees to remain with tree protection fencing to the approximate diameter of foliage (dripline of the tree) to prevent damage to the trunk, foliage and root system by construction equipment and procedures.

C. Place tree protection fencing as required to protect other plants, adjacent property areas to remain uncleared, monuments, and existing improvements from damage.

D. The Contractor shall repair or replace immediately any damage to existing trees or root systems that are to remain and to trees that are to be transplanted. The Contractor shall employ an arborist licensed in the jurisdiction of the Project to determine the repair and replacement needs and methods for approval by the Engineer.

E. Replace damaged shrubs and other vegetation designated to remain with the same size and species.

F. The tree protection fencing shall be maintained for the duration of construction operations. The work shall include immediate replacement of any damaged fence. Fencing shall be removed from the site at the completion of construction operations. The fencing disposal shall be in accordance with local, state, and federal laws and regulations for the disposal of the material.

3.02 UTILITIES

A. Notify all corporations, companies, individuals, or local authorities owning or having jurisdiction over utilities running to, though, or across areas to be affected by site clearing operations.

B. Locate and identify existing utilities that are to remain and protect them from damage.

C. For utilities to be disconnected, have utility services disconnected in accordance with the requirements of the utility owner.

3.03 CLEARING AND GRUBBING

A. Clearing shall include cutting, removal, and off-site disposal of trees, bushes, shrubs, stumps, fallen timber, brush, refuse, trash, fencing and other incidental materials not required for reuse on the site.

B. The Contractor shall grub the area within the clearing limits to completely remove stumps and root systems, except for those to remain.

C. Depressions, excavations and voids resulting from the removal of stumps or roots shall be filled with suitable material and compacted as specified under Section 310000 – EARTHWORK.

3.04 SELECTIVE CLEARING AND THINNING

A. Selective clearing and thinning shall be completed as directed by the Landscape Architect. Approximate limits of selective clearing and thinning are shown on the Drawings.

B. The work shall include the removal of dead and diseased tree limbs and plants and pruning and removal of live vegetation that interferes with the growth of other trees and plants. Areas of dense growth shall be thinned to provide room for healthy growth.

3.05 DEMOLITION REQUIREMENTS

A. Conduct demolition operations in a manner that will prevent damage to adjacent structures, utilities, pavements, and other facilities to remain.

B. Cease operations immediately if any damage, settlement or other adverse effect on adjacent structures occurs. However, if an obvious unsafe condition is created that would potentially cause injury to persons or undue harm to properties, the Contractor shall take whatever measures are warranted to prevent such injury or harm. Immediately notify the Engineer and regulatory authorities. Do not resume operations until conditions are corrected, damage repaired, and approval has been received from the appropriate authorities and the Owner's Representative.

C. Obtain written permission from adjacent property owners when demolition equipment will traverse, infringe upon, or affect access to their property. Copies of the permission documents shall be submitted to the Engineer.

D. Provide hoses and water connections. Spray water on demolition debris to minimize dust.

E. Clean adjacent structures and improvements of dust, dirt, and debris caused by demolition operations. Return adjacent areas to condition which existed prior to start of work.

F. All hazardous waste removal shall be performed by a hazardous waste contractor qualified and duly licensed in the jurisdiction of the Project to remove, transport, and dispose of each type of hazardous substance.

G. Comply with federal, state, and local regulations pertaining to the crushing, processing, and reuse of Asphalt Pavement, Brick and Concrete Rubble.

3.06 DEMOLITION

A. Demolish buildings completely and remove from site, or remove intact, in accordance with the approved permits, procedures and operational sequence.

B. Locate demolition equipment and remove materials in a manner that prevents excessive loading to supporting walls, floors, or framing.

C. Remove all debris and other materials from basement areas.

D. The Contractor may break up and leave in place concrete floor slabs that are 4 or more feet below finished grade. Remove all concrete foundations and floors within 4 feet of finished grade.

3.07 FILLING BASEMENT AND VOIDS

A. Completely fill all voids including, but not limited to: basement areas, excavation areas, and voids resulting from demolition or removal of structures including underground fuel storage tanks, wells, and cisterns with suitable material as specified in Section 310000 – EARTHWORK.

B. Areas to be filled shall be free of standing water, frost, frozen, and unsuitable material prior to fill placement.

C. Place and compact fill materials in conformance with the requirements of Section 310000 – EARTHWORK.

D. Grade surface of filled areas to match adjacent grades and slope to provide surface drainage.

3.08 REMOVAL AND ABANDONMENT OF UTILITIES

A. All existing structures, utilities, and appurtenances of any kind shall be completely removed within the limits of excavation for the new buildings and for a distance of 10 feet beyond. Remove all utilities beneath exterior columns and for a distance of 10 feet beyond.

B. Outside the limits of excavation for the new buildings, all abandoned utilities and utility structures greater than 8 inches in diameter located at least 4 feet below bottom of finished grade shall be sealed with concrete or brick masonry at the limit of excavation. All utilities shall be entirely removed within 4 feet of finished grade.

C. Manholes and catch basins designated to be abandoned shall have all lines plugged with brick and mortar prior to filling with sand or gravel. The top 4 feet of these structures shall be removed and the bottom slab broken up to permit drainage prior to filling.

D. The Contractor shall remove frames, covers, and grates from manholes, catch basins and gate valves and satisfactorily store and protect them until they are required for reuse in the work. Existing frames, covers, and grates determined by the Engineer to be unsuitable for reuse shall be removed from the site.

3.09 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove from site all materials resulting from site clearing and demolition operations.

B. No burning of any material will be allowed.

END OF SECTION 311000

SECTION 311100

CLEARING AND GRUBBING

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 clearing and grubbing as shown on the drawings and/or specified herein, including but not necessarily limited to the following:

1. Clearing site of debris, grass and other plant life in preparation for Site or building earthwork.

2. Protection of existing structures, trees or vegetation indicated in contract documents to remain.

3. Removal of existing sidewalks, drives, curbs, etc.

4. Removal of asphalt pavement where indicated on contract documents and as specified herein.

5. Stripping topsoil, if necessary, from areas that are to be incorporated into limits of project.

6. Disposal of cleared, grubbed and stripped materials in accordance with all applicable codes and ordinances.

1.3 RELATED SECTIONS

A. Selective Tree and Shrub Removal and Trimming - Section 311300.

B. Site Excavating, Backfilling and Compacting - Section 312300.

C. Erosion and Sediment Control - Section 312500.

D. Bituminous Paving - Section 321216.

E. Portland Cement Concrete Paving - Section 321313.

1.4 JOB CONDITIONS

A. Protection of Existing Improvements

1. Provide protections necessary to prevent damage to existing improvements indicated to remain in place.

2. Protect improvements on adjoining properties and on the Owner's property.

3. Restore damaged improvements to their original condition, as acceptable to parties having jurisdiction.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Construct temporary erosion control systems to protect adjacent properties and water resources from erosion and sedimentation.

B. Owner will obtain the erosion and sedimentation (E&S) related permit from local authorities, governing the discharge of stormwater from the construction site.

C. Contractor shall be totally responsible for conducting soil erosion and sediment control and the storm water management practices in accordance with Owner's E&S permit and for enforcement action taken or imposed by federal, state and local agencies, including cost of fines, construction delays, and remedial actions resulting from Contractor's failure to comply with all provisions of the E&S permit.

1.6 PROJECT CONDITIONS

A. Contractor to provide a thorough inspection of the site prior to bidding and accept the site as is.

B. Variations to conditions or discrepancy in actual or described as proposed conditions as they apply to site preparation operations are to be brought to the attention of the Owner prior to commencement of sitework.

PART 2 PRODUCTS

2.1 MATERIALS

A. Off-site materials shall be transported to project using well maintained and operating vehicles. Once on site, transporting vehicles shall stay on designated haul roads and shall at no time endanger improvements by rutting, overloading or pumping.

PART 3 EXECUTION

3.1 PREPARATION

A. Site Inspection

1. Prior to all work of this Section, carefully inspect the entire site and all objects designated to be removed and to be preserved.

2. Locate all existing utility lines and determine all requirements for disconnecting and capping.

3. Locate all existing active utility lines traversing the site and determine the requirements for their protection.

B. Clarification

1. The drawings do not purport to show all objects existing on the site.

2. Before commencing the work of this Section, verify by inspection all objects to be removed and all objects to be preserved.

C. Scheduling

1. Schedule all work in a careful manner with all necessary consideration for neighbors and the public.

2. Avoid interference with the use of, and passage to and from, adjacent buildings and facilities.

D. Disconnection of Utilities: Before starting site operations, disconnect or arrange for the disconnection of all utility services designated to be removed, performing all such work in accordance with the requirements of the utility company or agency involved.

3.2 PROTECTION

A. Locate and identify existing utilities that are to remain and protect from damage.

B. Protect trees, plant growth, wetlands and features not designated for removal.

C. Conduct operations with minimum interference to public or private accesses and facilities. Maintain ingress and egress at all times and clean or sweep roadways daily as required by the governing authority. Dust control shall be provided with sprinkling systems or equipment provided by Contractor.

D. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If marker needs to be removed it shall be referenced by a licensed land surveyor and replaced, as necessary, by same at Contractor's cost.

E. Provide traffic control as required, per local and county requirements.

F. Protection of Utilities: Preserve in operating condition all active utilities traversing the site and designated to remain.

3.3 DEMOLITION AND REMOVAL

A. Demolish and remove all concrete slabs, asphaltic concrete pavement designated to be removed, septic tanks, fuel lines, utility lines designated for abandonment, and all other items designated to be removed or necessary to be removed prior to construction of this work.

3.4 CLEARING, GRUBBING AND STRIPPING

A. General

1. Remove vegetation, improvements, or obstructions interfering with installation of new construction. Remove such items elsewhere on the site or premises as specifically indicated. Removal includes stumps and roots.

2. Carefully and cleanly cut roots and branches of trees indicated to be left standing where such roots and branches obstruct new construction.

B. The Contractor shall strip all asphalt within the building footprint area and 10 ft. beyond, and from any other areas to receive new fill. Removed asphalt can be milled by the Contractor and asphalt millings can be reused as subbase material beneath new pavements. Asphalt to be used as recycled material shall be milled to form a well-graded material having a maximum particle size of two inches. The Contractor shall provide dust control measures during any milling process. Excess asphalt materials shall be properly disposed of in accordance with all applicable codes and ordinances.

C. Topsoil

1. Topsoil is defined as friable clay loam surface soil found in a depth of not less than four (4) inches. Satisfactory topsoil is reasonably free of subsoil, clay lumps, stones and other objects over two (2) inches in diameter, and without weeds, roots, and other objectionable material.

2. Strip topsoil to whatever depths encountered in a manner to prevent intermingling with the underlying subsoil or other objectionable material.

3. Remove heavy growths of grass from areas before stripping.

4. Where trees are indicated to be left standing, stop topsoil stripping a sufficient distance to prevent damage to the main root system.

5. Stockpile topsoil in storage piles in areas directed by the Architect. Construct storage piles to freely drain surface water. Cover storage piles if required to prevent wind blown dust.

D. Clearing and Grubbing

1. Clear the site of trees, shrubs, and other vegetation, except for that indicated to be left standing.

2. Completely remove stumps, roots, and other debris protruding through the ground surface.

3. Use only hand methods for grubbing inside the drip line of trees indicated to be left standing.

4. Fill depressions caused by clearing and grubbing operations with soil material meeting the requirements of Section 312000, unless further excavation or earthwork is indicated.

5. Place fill material in horizontal layers not exceeding eight (8) inches loose depth, and thoroughly compact to a density equal to adjacent original ground.

3.5 DISPOSAL OF WASTE MATERIALS

A. Burning is not permitted on the Owner's property.

B. Removal all debris from the site and dispose of all removed material legally. Leave the site in a neat and orderly condition to the approval of the Architect.

END OF SECTION

SECTION 311300

SELECTIVE TREE AND SHRUB REMOVAL AND TRIMMING

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 selective tree and shrub removal and trimming as shown on the drawings and/or specified herein, including but not necessarily limited to the following:

1. Removal of trees and other vegetation.

1.3 RELATED SECTIONS

A. Clearing and Grubbing - Section 311100.

1.4 PROJECT CONDITIONS

A. Criteria for Protecting Remaining Trees

1. Box trees within 25 feet of a building site to prevent mechanical injury using 4’ high snow fence. Fencing shall be installed at the drip line of the tree branches or beyond.

2. Boards shall not be nailed to trees during building operations.

3. Feeder roots shall not be cut in an area inside the drip line of the tree branches.

4. Damaged trunks or exposed roots shall have damaged bark removed immediately and no paint shall be applied. Exposed roots shall be covered with topsoil immediately after excavation is complete. Roots shall be pruned to give a clean, sharp surface amenable to healing. Roots exposed during hot weather shall be irrigated to prevent permanent tree injury. Care for serious injury shall be prescribed by a professional forester or certified tree expert.

5. Tree limb removal, where necessary, shall be done as natural target pruning to remove the desired branch as close as possible to the branch collar. There shall be NO flush cuts. No tree paint shall be applied. All cuts shall be made at the outside edge of the branch collar. Removal of a 'V' crotch shall be considered for free standing specimen trees to avoid future splitting damage.

PART 2 PRODUCTS

(Not Applicable)

PART 3 EXECUTION

3.1 PREPARATION

A. Verify existing plant life that is to remain and any clearing limits are clearly tagged, identified and marked in such manner as to insure their safety throughout construction operations.

3.2 SITE CLEARING

A. Remove vegetation, improvements, or obstructions interfering with installation of new construction. Remove such items elsewhere on the site or premises as specifically indicated. Removal includes stumps and roots.

B. Carefully and cleanly cut roots and branches of trees indicated to be left standing where such roots and branches obstruct new construction.

3.3 PROTECTION

A. Protect trees, plant growth, wetlands and features not designated for removal.

B. Conduct operations with minimum interference to public or private accesses and facilities. Maintain ingress and egress at all times and clean or sweep roadways daily as required by the governing authority. Dust control shall be provided with sprinkling systems or equipment provided by Contractor.

C. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If marker needs to be removed it shall be referenced by a licensed land surveyor and replaced, as necessary, by same at Contractor’s cost.

D. Provide traffic control as required, per local and county requirements.

3.4 TREE AND SHRUB REMOVAL

A. Unless otherwise indicated on construction drawings, the Contractor shall remove trees, shrubs, grass, other vegetation, improvements or obstructions interfering with installation of new construction. Removal includes digging out stumps and roots. Depressions caused by clearing operations are to be filled to subgrade elevation to avoid ponding of water. Satisfactory fill material shall be placed in accordance with Earthwork specifications.

B. Remove grass, trees, plant life, stumps and other construction debris from site to dump Site that is suitable for handling such material according to state laws and regulations.

3.5 DISPOSAL OF WASTE MATERIALS

A. Burning is not permitted on the Owner's property.

B. Removal all debris from the site and dispose of all removed material legally. Leave the site in a neat and orderly condition to the approval of the Architect.

END OF SECTION

SECTION 312300

SITE EXCAVATING, BACKFILLING AND COMPACTING

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 site excavating, backfilling and compacting as shown on the drawings and/or specified herein, including, but not necessarily limited to, the following:

1. Lay out and stake all lines and levels.
2. Protection and safeguards.
3. Excavating for footings, foundations and below grade construction.
4. Excavating for all underground mechanical and electrical utilities.
5. Filling and backfilling to attain indicated grades.
6. Preparation of sub-grade for walks, pavements, retaining walls and grass areas including grading.
7. Aggregate sub-base below concrete slabs.
8. Dewatering.
9. Shoring and bracing.

1.3 RELATED SECTIONS

A. Clearing and Grubbing - Section 311100.

B. Selective Tree and Shrub Removal and Trimming - Section 311300.

C. Bituminous Paving - Section 321216.

D. Portland Cement Concrete Pavement - Section 321313.

E. Landscape Grading - Section 329119.

1.4 JOB CONDITIONS

A. Dust Control

1. Use all means necessary to control dust on or near the work.
2. Thoroughly moisten all surfaces as required to prevent dust being a nuisance to the public, neighbors, and performance of other work on the site.

B. Protection

1. Barricade open excavations occurring as part of this work and post with warning lights. Operate warning lights as recommended by authorities having jurisdiction.

2. Provide the necessary safeguards to prevent accidents, to avoid all unnecessary hazards and protect the public, the work and the property at all times, including Saturdays, Sundays and holidays.

3. Be responsible for any and all damages which may arise or occur to any party whatsoever by reason of the neglect in providing proper lights, guards, barriers, or any other safeguards to prevent damage to property, life and limb.

4. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.

C. Existing Underground Utilities

1. Locate existing underground utilities in the areas of work. If utilities are to remain in place, provide adequate means of protection during earthwork operations.

2. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult the utility Owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.

3. Do not interrupt existing utilities serving facilities occupied and used by Owner or others, except when permitted in writing by the Architect and then only after acceptable temporary utility services have been provided.

4. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shut-off of services if lines are active.

D. Explosives: Do not bring explosives onto site or use in work without prior written permission from authorities having jurisdiction. Contractor is solely responsible for handling, storage, and use of explosive materials when their use is permitted.

1.5 EROSION AND SEDIMENTATION CONTROL

A. The Contractor is responsible for the performance of all work, furnishing all materials and installing all measures required to reasonably control soil erosion resulting from construction operations and preventing excessive flow of sediment from the construction site. This work must be accomplished in accordance with the requirements of local and state regulatory agencies.

PART 2 PRODUCTS

2.1 ON-SITE MATERIAL

A. All on-site material to be used as fill shall be soil or soil-rock mixture which is free from organic matter and other deleterious substances. It shall contain no rocks or lumps over two (2) inches in greatest dimension.

2.2 IMPORTED FILL MATERIAL

A. Imported fill material shall consist of clean, well graded sand and/or gravel containing less than fifteen (15) percent by weight of materials passing a No. 200 sieve and a maximum particle size of four (4) inches.

2.3 AGGREGATE SUB-BASE BELOW SLAB ON GRADE

A. Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, with one-hundred (100) percent passing a 1-1/2" sieve and not more than five (5) percent passing a No. 4 sieve.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where earthwork 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

A. Familiarization: Prior to all work of this Section, become thoroughly familiar with the site, site conditions, and all portions of the work falling within this Section. Correct any unsatisfactory conditions encountered.

B. Backfilling Prior to Approvals

1. Do not allow or cause any of the work performed or installed to be covered up or enclosed by work of this Section prior to all required inspections and approvals.

2. Should any of the work be so enclosed or covered up before it has been approved, uncover all such work at no additional cost to the Owner.

3. After the work has been completely inspected and approved, make all repairs and replacements necessary to restore the work to the condition in which it was found at the time of uncovering, all at no additional cost to the Owner.

3.3 FINISH ELEVATIONS AND LINES

A. For setting and establishing layout of building and finish elevations and lines, secure the services of a registered civil engineer or a licensed land surveyor acceptable to the Architect. Carefully preserve all data and all monuments set by the civil engineer or surveyor and, if displaced or lost, immediately replace at no additional cost to the Owner.

3.4 EXCAVATION

A. Excavation is unclassified and includes excavation to subgrade elevations indicated, regardless of character of materials and obstructions encountered.

B. Excavation Classifications: The following classifications of excavation will be made when rock excavation is encountered in work.

1. Earth excavation includes excavation of pavements and other obstructions visible on ground surface; underground structures, utilities, and other items indicated to be demolished and removed; together with earth and other materials encountered that are not classified as rock or unauthorized excavation.

2. Rock excavation in trenches and pits includes removal and disposal of materials and obstructions encountered which cannot be excavated with a 1.0 cubic yard (heaped) capacity, forty-two (42) inches wide bucket on a track mounted power excavator equivalent to Caterpillar Model 215, rated not less than ninety (90) HP flywheel power and thirty-thousand (30,000) pound drawbar pull. Trenches in excess of 10' - 0" in width and pits in excess of 30' - 0" in either length or width are classified as open excavation.

3. Rock excavation in open excavations includes removal and disposal of materials and obstructions encountered which cannot be dislodged and excavated with modern track mounted heavy duty excavating equipment without drilling, blasting or ripping. Rock excavation equipment is defined as Caterpillar Model No. 973 or No. 977k, or equivalent track mounted loader, rated at not less than one-hundred-seventy (170) HP flywheel power and developing forty-thousand (40,000) pound break out force (measured in accordance with SAE J732C).

4. Typical of materials classified as rock are boulders 1/2 cubic yard or more in volume, solid rock, rock in ledges, and rock hard cementitious aggregate deposits.

5. Intermittent drilling, blasting, or ripping performed to increase production and not necessary to permit excavation of material encountered will be classified as earth excavation.

6. Do not perform rock excavation work until material to be excavated has been cross sectioned and classified by Soils Engineer. Such excavation will be paid on the basis of contract conditions relative to changes in the work.

C. Rock pavement lines are limited to the following:

1. Two feet outside of concrete work for which forms are required, except footings.

2. One foot outside perimeter of footings.

3. In pipe trenches, six (6) inches below invert elevation of pipe and two (2) feet wider than inside diameter of pipe, but not less than three (3) feet minimum trench width.

4. Neat outside dimensions of concrete work where no forms are required.

5. Under slabs on grade, six (6) inches below bottom of concrete slab.

D. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimension without specific direction of Soils Engineer. Unauthorized excavation, as well as remedial work directed by Soils Engineer, shall be at Contractor's expense.

1. Under footings, foundation bases, or retaining walls, fill unauthorized excavation by extending indicated bottom elevation of footing or base to excavation bottom, without altering required top elevation. Lean concrete fill may be used to bring elevations to proper position, when acceptable to Soils Engineer.

2. Elsewhere, backfill and compact unauthorized excavations as specified for authorized excavations of same classifications, unless otherwise directed by Soils Engineer.

E. Additional Excavation: When excavation has reached required subgrade elevations, notify Soils Engineer who will make an inspection of conditions.

1. If unsuitable bearing materials are encountered at required subgrade elevations, carry excavations deeper and replace excavated material as directed by the Soils Engineer.

Excavation of unsuitable material must extend laterally beyond the edge of the footing or slab for a distance equal to or greater than the required depth of the excavation.

2. Removal of unsuitable material and its replacement as directed will be paid on basis of contract conditions relative to changes in work.

F. Perform excavation with drip line of large trees to remain by hand, and protect the root system from damage or dryout to the greatest extent possible. Maintain moist condition for root system and cover exposed roots with burlap. Paint root cuts of one (1) diameter and larger with emulsified asphalt tree paint.

G. Stability of Excavations: Slope sides of excavations to comply with local codes and ordinances having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated. Maintain sides and slopes of excavations in safe condition until completion of backfilling.

H. Shoring and Bracing: Provide materials for shoring and bracing, such as sheet piling, uprights, stringers, and cross braces, in good serviceable condition.

1. Establish requirements for trench shoring and bracing to comply with local codes and authorities having jurisdiction.

2. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Carry down shoring and bracing as excavation progresses.

I. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.

1. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations. Maintain water levels below base of excavation to control hydrostatic pressure on subgrade soils.

2. Establish and maintain temporary drainage ditches and other diversion outside excavation limits to convey rainwater and water removed from excavations to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches.

J. Material Storage: Stockpile satisfactory excavated materials where directed until required for backfill or fill. Place, grade and shape stockpiles for proper drainage.

1. Locate and retain soil materials away from edge of excavations. Do not store within drip line of trees indicated to remain.

2. Dispose of excess soil material and waste materials not re-used.

K. Excavation for Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 feet, and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.

1. In excavating for footings and foundations, take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed. Trim bottoms to required lines and grades to leave solid base to receive other work.

L. Excavation for Pavements: Cut surface under pavements to comply with cross sections, elevations and grades.

M. Excavation for Trenches: Dig trenches to the uniform width required for particular item to be installed, sufficiently wide to provide ample working room. Provide six (6) inches to nine (9) inches clearance on both sides of pipe or conduit.

1. Excavate trenches to depth indicated or required. Carry depth of trenches for piping to establish indicated flow lines and invert elevations. Beyond building perimeter, keep bottoms of trenches sufficiently below finish grade to avoid freeze ups.

2. Where rock is encountered, carry excavation six (6) inches below required elevation and backfill with a six (6) inch layer of crushed stone or gravel prior to installation of pipe.

3. For pipes or conduit five (5) inches or less in nominal size and for flat bottomed multiple duct conduit units, do not excavate beyond indicated depths. Hand excavate bottom cut to accurate elevations and support pipe or conduit on undisturbed soil.

4. For pipes or conduit six (6) inches or larger in nominal size, tanks and other mechanical/electrical work indicated to receive subbase, excavate to subbase depth indicated, or if not otherwise indicated, to six (6) inches below bottom of work to be supported.

5. Except as otherwise indicated, excavate for exterior water-bearing piping (water, steam, condensation, drainage) so top of piping is not less than three (3) feet to six (6) feet below finished grade.

6. Grade bottoms of trenches as indicated, notching under pipe bells to provide solid bearing for entire body of pipe.

7. Backfill trenches with concrete where trench excavations pass within eighteen (18) inches of column or wall footings and which are carried below bottom of such footings, or which pass under wall footing. Concrete shall conform to the requirements of Section 03300.

8. Do not backfill trenches until tests and inspections have been made and backfilling authorized by Architect/Engineer. Use care in backfilling to avoid damage or displacement of pipe systems.

9. For piping or conduit less than two (2) feet to six (6) inches below surface of roadways, provide four (4) inch thick concrete base slab support. After installation and testing of piping or conduit, provide minimum four (4) inch thick encasements (sides and top) of concrete prior to backfilling or placement of roadway subbase.

N. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than thirty-five (35) degrees F. (1 degree Centigrade).

3.5 COMPACTION

A. Once the design subgrades are established, the filled and the indigenous soils shall be proof-compacted using a smooth drum self-propelled vibratory compactor which develops a centrifugal force of at least 40,000 pounds and a frequency of at least 1,200 vpm. The compactor shall complete eight (8) passes across the exposed soil grades to improve their density and uniformity.

B. General: Control soil compaction during construction providing minimum percentage of density specified for each area classification indicated below.

C. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum dry density as determined in accordance with ASTM D 1557.

1. Structures, Steps, Pavements: Compact each layer of backfill or fill material to ninety-five (95) percent maximum dry density, at + 2% of its optimum moisture content.

2. Lawn or Unpaved Areas: Compact top six (6) inches of subgrade and each layer of backfill or fill material to eighty-five (85) percent maximum dry density.

3. Walkways: Compact each layer of backfill or fill material to ninety (90) percent maximum dry density.

D. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade or layer or soil material, to prevent free water appearing on surface during or subsequent to compaction operations.

1. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.

a. Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing until moisture content is reduced to within + 2% of its optimum moisture content.

3.6 BACKFILL AND FILL

A. General: Place acceptable soil material in layers to required subgrade elevations for each area classification listed below.

1. In excavations, use satisfactory excavated or borrow material.

2. Under grassed areas, use satisfactory excavated or borrow material.

3. Under walks and pavements, use aggregate subbase material.

4. Under steps, use aggregate subbase material.

5. Under retaining walls, use aggregate subbase material.

6. Under piping and conduit, use existing subbase material where subbase is indicated under piping or conduit; shape to fit bottom ninety (90) degrees of cylinder.

B. Backfill excavations as promptly as work permits, but not until completion of the following:

1. Acceptance of construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.

2. Inspection, testing, approval, and recording locations of underground utilities.

3. Removal of concrete formwork after concrete has attained twenty-eight (28) day design strength.

4. Removal of shoring and bracing, and backfilling of voids with satisfactory materials. Cut off temporary sheet piling driven below bottom of structure or utilities, or leave in place if required.

5. Removal of trash and debris.

6. Permanent or temporary horizontal bracing is in place on horizontally supported walls.

C. Ground Surface Preparation: Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow, strip, or break up sloped surfaces steeper than one (1) vertical to four (4) horizontal so that fill material will bond with existing surface.

1. When existing ground surface has a density less than that specified under "Compaction" for particular area classification, break up ground surface, pulverize, moisture condition to optimum moisture content, and compact to required depth and percentage of maximum density.

D. Placement and Compaction: Place backfill and fill materials in layers not more than eight (8) inches in loose depth for material compacted by heavy compaction equipment, and not more than four (4) inches in loose depth for material compacted by hand operated tampers.

1. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

2. Place backfill and fill materials evenly adjacent to structures, piping or conduit to required elevations. Take care to prevent wedging action of backfill against structures or displacement of piping or conduit by carrying material uniformly around structure, piping or conduit to approximately same elevation in each lift.

3.7 GRADING

A. General: Uniformly grade areas within limits of grading under this Section, including adjacent transition areas. Smooth finished surface within specified tolerances, compact with uniform levels or slopes between points where elevations are indicated, or between such points and existing grades.

B. Grading Outside Building Lines: Grade Areas adjacent to building lines to drain away from structures and to prevent ponding.

1. Finish surfaces free from irregular surface changes.

2. Lawn or Unpaved Areas: Finish areas to receive topsoil to within not more than 0.10 feet above or below required subgrade elevations.

3. Walks: Shape surface of areas under walks to line, grade and cross section, with finish surface not more than 0.10 feet above or below required subgrade elevation.

4. Pavements: Shape surface of areas under pavement to line, grade and cross section, with finish surface not more than 1/2" above or below required subgrade elevation.

C. Compaction: After grading, compact subgrade surfaces to the depth and indicated percentage of maximum density for each area classification.

3.8 MAINTENANCE

A. Protection of Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris.

1. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.

B. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape, and compact to required density prior to further construction.

C. Settling: Where settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.9 DISPOSAL OF EXCESS AND WASTE MATERIALS

A. Removal from Owner's Property: Remove waste materials, including unacceptable excavated material, trash and debris, and dispose of it off Owner's property.

END OF SECTION

SECTION 312500
EROSION AND SEDIMENTATION CONTROLS

PART 1 – GENERAL

1.01 DESCRIPTION

A. This Section specifies requirements for temporary and permanent erosion and sedimentation control provisions as they relate to the construction process.

B. The work includes:

1. Providing and maintaining all temporary erosion and sedimentation control measures shown on the Drawings and required by the Engineer during the life of the Contract to control soil erosion and water pollution.
2. The installation and maintenance of additional silt fence, berms, ditches, sedimentation basins, construction exits, fiber mats, catch basin filters, straw, netting, gravel, trenches, mulches, grasses, slope drains, and other approved erosion control devices or methods, needed to protect any areas on or off site in accordance with the Storm Water Pollution Prevention Plan (SWPPP) developed for the project which is required by the EPA or its' locally designated agency.

1.02 RELATED SECTIONS

A. Sections which directly relate to the work of this Section include but are not limited to:

1. Section 311000 – SITE CLEARING
2. Section 310000 – EARTHWORK

1.03 DEFINITION AND COORDINATION OF EROSION AND SEDIMENTATION CONTROL PROVISIONS

A. Permanent erosion and sedimentation control measures are defined as those elements that are to be incorporated into the final project product, including but not necessarily limited to such items as: finish paving and landscape, detention basin forebays, swales and ditches, berms, and other such items.

B. Temporary erosion and sedimentation control measures are defined as those elements that are required by permit approvals and necessary to be installed by the Contractor to meet federal, state and local regulations for the construction program, including, but not necessarily limited to, such items as: silt fences, berms, portable sedimentation basins, straw bales, check dams, and other such items, all of which shall be removed by the Contractor after installation of permanent erosion and sedimentation control measures, stabilization of the site, and prior to final completion of the project.

C. The temporary control provisions shall be coordinated with the permanent erosion and sedimentation control features to the extent practical to ensure economical, effective, and continuous erosion and sedimentation controls throughout the construction and post-construction periods.

1.04 LAWS AND REGULATIONS

A. Compliance with the NYSDEC SPDES General Permit for Stormwater Discharges from Construction Activity, Permit No. GP-0-20-001.

1.05 PRIOR TO CONSTRUCTION

A. Prior to the start of the construction, the Contractor shall submit to the Engineer the following: schedules for the construction of required stormwater detention basins, temporary and permanent erosion and sediment control work, clearing and grubbing, grading, structures at watercourses, construction, and paving. No work shall be started until control schedules and methods of operations have been submitted to the Engineer.

B. Proof of submittal and receipt of an acknowledgement of the Notice of Intent (NOI) for a SPDES General Permit for Stormwater Discharges from Construction Activity, Permit No. GP-0-20-001 is required prior to the kickoff meeting.

1.06 CONSTRUCTION OPERATIONS

A. When in the opinion of the Engineer it becomes necessary, the Engineer will inform the Contractor of construction procedures and operations that jeopardize erosion and sedimentation control provisions. If these construction procedures and operations are not corrected promptly, the Owner may suspend the performance of any or all construction until corrections have been made, and such suspension shall not be the basis of any claim by the Contractor for additional compensation from the Owner nor for an extension of time to complete the Work.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Temporary erosion control seed for quick growing grasses such as wheat, rye or oats shall be planted only when permanent grasses be planted due to the growing season. All permanent grass areas planted with temporary erosion control seed shall be replaced with permanent seed. Apply seed mixture at a rate of 100 pounds per acre.

Seed	Percent by Weight	Percent Germination Minimum
Winter Rye	80 Minimum	85
Red Fescue(Creeping)	4 Minimum	80
Perennial Rye Grass	3 Minimum	90
Red Clover	3 Minimum	90
Other Crop Grass	0.5 Maximum	
Noxious Weed Seed	0.5 Maximum	
Inert Matter	1.0 Maximum	

B. Erosion Control Blanket/Fabric Netting

1. Curlex blankets, as manufactured by American Excelsior Company
2. Erosion Control Blankets as manufactured by North American Green

C. Silt fence fabric shall be a woven fabric comprised of high tenacity polypropylene yarns. Silt fence shall be prefabricated with 1.25” (nominal) square hardwood posts. Silt fence shall meet the following criteria:

Grab Tensile Strength	100 pounds
Grab Tensile Elongation	15%
Trapezoidal Tear Strength	50 pounds
Mullen Burst Strength	300 pounds
Puncture Strength	50 pounds

Apparent Opening Size	#30 US Sieve
Permitivity	0.10 sec^-1
Flow rate	8 gal/min/sf
UV Resistance at 500 Hours	70% Strength Retained

D. Filter fabric at construction entrance shall be a woven fabric comprised of high tenacity polypropylene yarns. Filter fabric shall meet the following criteria:

Wide Width Tensile Strength	175 pounds/inch
Grab Tensile Strength	315 pounds
Grab Tensile Elongation	15%
Trapezoidal Tear Strength	120 pounds
Mullen Burst Strength	600 pounds
Puncture Strength	120 pounds
Apparent Opening Size	#40 US Sieve
Permitivity	0.05 sec^-1
Flow rate	4 gal/min/sf
UV Resistance at 500 Hours	70% Strength Retained

E. Silt Sacks and Sediment Control Devices

1. Silt sacks shall be a woven polypropylene geotextile fabric with strength per ASTM D4884 manufactured to fit the opening of the catch basin. Silt sacks shall be Siltsack® as manufactured by ACF Environmental, Inc., or approved equal.
2. Silt sacks shall be manufactured with a high flow bypass weir for large inflow events. Field modification, including cutting or puncturing of the fabric, will not be allowed.
3. Install at locations indicated on the Drawings.

F. Compost-Filled Siltsocks

1. Siltsocks shall consist of 12-inch diameter biodegradable cotton mesh netting filled with compost filter media.
2. Siltsocks shall be Siltsoxx®, as manufactured by Filtrexx, or approved equal.

G. Straw Wattles shall consist of tubular polypropylene netting filled with agricultural straw fibers. Wattles shall be 12-inch diameter minimum unless otherwise indicated by Engineer.

PART 3 – EXECUTION

3.01 EROSION AND SEDIMENTATION CONTROL – STRAW BALES

A. Straw bales shall be installed at the locations, shown on the Drawings and in general as follows:

1. Toe of slope of embankment construction to filter all runoff flowing to off-site discharges
2. Toe of temporary earthwork stockpile slopes
3. Across construction ditches prior to entry into drainage system or waterway, and at 50-foot intervals along the remainder of the ditch
4. Surrounding completed drainage inlets.
5. Other locations shown on the Contract Drawings and required by laws, regulations, and permits.

B. Straw bales shall be installed in line with each bale installed tight against the previous bale to form a continuous barrier. Secure bales in place with two (2) stakes per bale. The bales shall be set in a trench approximately 4 inches into the ground. Soil shall be placed on the upside slope of the bales. Deteriorated, destroyed, or rotted bales shall be replaced immediately. Sediment

shall be removed and disposed of periodically from behind the straw bales. The accumulated sediment shall not be allowed to rise above the mid-height of the bale. All sediment, straw bales, and appurtenances shall be removed and disposed of at the completion of the Contract.

3.02 TEMPORARY EROSION CONTROL MATS

A. Erosion control mats shall be installed in accordance with the manufacturer's recommendations.

B. Areas to receive mats shall be smooth graded and compacted. Remove all rocks, dirt clods, vegetation, and other obstructions that may cause damage to the mats.

C. Unroll mats parallel to the direction of water flow and lay flat against the ground. Overlap roll ends a minimum of 1 foot with upslope mat on the top to prevent uplift of mat end by water flow. Overlay adjacent edges of mat by six (6) inches. Extend mat a minimum of 2 feet above the crest of steep slopes and anchor by excavating a 6-inch-deep trench, and secure end of mat in trench using staples or pins furnished by manufacturer of mat. After securing mat end in place, backfill and compact trench.

3.03 SILT FENCE

A. Silt fence shall be installed at locations as shown on the Drawings.

B. Supporting posts shall be spaced 4 feet on center and driven at least 1 foot into the ground. Posts shall be 1-1/2 inch square or heavier wood posts or standard steel posts.

C. Fabric shall be anchored in a 4-inch deep trench dug on the upslope side of the posts. The trench shall be at least 4 inches wide. The fabric shall be laid in the trench, backfilled, and compacted.

D. Fabric rolls shall be spliced at posts. The fabric shall be overlapped 6 inches, folded over, and then securely fastened to posts.

E. Silt fences shall be inspected immediately after each storm event and at least daily during prolonged rainfall.

3.04 CONSTRUCTION REQUIREMENTS – TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. The Contractor shall construct all permanent erosion and sedimentation control features at the earliest practical time as outlined in the accepted schedule. Temporary erosion and sedimentation control measures shall be used to correct conditions that develop during construction which were unforeseen, but are needed prior to installation of permanent erosion and sedimentation control features, or that are needed temporarily to control erosion or sedimentation which develops during construction operations.

B. Where erosion is likely to be a problem, clearing and grubbing operations shall be scheduled and performed so that grading operations and permanent erosion and sedimentation control features can follow immediately thereafter, if conditions permit; otherwise, temporary erosion and sedimentation control measures will be required between successive construction stages.

C. Contractor shall be responsible for controlling erosion within the project area and retaining sediment on-site away from sensitive environmental resources. Any fines, construction delays, remedial actions, or incarceration resulting from the Contractor's failure to comply with these provisions shall be the responsibility of the Contractor and not the Owner.

D. Failure by the Contractor to control erosion, pollution, and siltation shall be cause for the Owner to employ outside assistance to provide the necessary corrective measures. The cost of such

assistance, including engineering costs, will be charged to the Contractor and appropriate deductions made from the Contractor's monthly progress payment.

E. The Contractor shall remove and properly dispose of sediment from control facilities as required by the Engineer. The Contractor shall modify and improve erosion and sedimentation control facilities and replace deteriorated straw bales and other devices as required by the Engineer.

F. Minimum temporary and permanent erosion and sedimentation control measures are shown on the Drawings. The Contractor shall strictly adhere to the minimum provisions shown. Additionally, temporary measures shall be selected and constructed by the Contractor in consultation with the Engineer to accommodate changing field conditions that develop during construction.

G. The temporary sedimentation basins shall be maintained from the start of construction until construction of the permanent detention basins and/or stormwater system is completed, and perimeter areas are stabilized. A temporary outlet shall be constructed above the expected sediment levels. Construction of the basins shall be sequenced so that the temporary outlet is installed and basin embankment is constructed with the material available from the initial site excavations.

H. Per NPDES Permit requirements, in disturbed areas where construction has permanently or temporarily ceased, the area must be stabilized within 14 days. If earth-disturbing activities will resume within 14 days, temporary stabilization is not required.

I. All disturbed areas shall be re-vegetated by loaming and seeding unless otherwise noted on the approved plan.

3.05 MAINTENANCE OF EROSION AND SEDIMENTATION CONTROL MEASURES

A. The Contractor shall check the condition of erosion and sedimentation control devices daily and maintain them in good operating condition. Straw bales shall be replaced when deteriorated.

B. The Contractor shall inspect the condition of diversion dikes and ditches, filter berms, interceptor dikes, sediment basins, and other erosion and sedimentation control devices after each rainstorm and during major storm events. Repairs shall be made as necessary.

C. During construction, temporary outlets of the drainage systems shall direct the flow to temporary or permanent sedimentation basins.

D. Temporary soil erosion and sedimentation control devices shall be removed and adjacent areas outside the limits of grading restored upon completion of the work or when required by the Engineer.

END OF SECTION 312500

SECTION 321100
BASE COURSES (PAVEMENT)

PART 1 – GENERAL

1.01 DESCRIPTION

A. This Section specifies requirements for the preparation of the subgrade for, and placement of, granular subbase and base materials for pavement areas.

B. The work includes:

1. Fine grading and compaction of pavement subgrade.
2. Furnishing, placing, and compacting of subbase and base materials.

1.02 RELATED SECTIONS

A. Other specification Sections which directly relate to the work of this Section include:

1. Section 310000 – EARTHWORK
2. Section 321216 – ASPHALT PAVING
3. Section 033055 – CAST-IN-PLACE CONCRETE (SITE)

PART 2 – PRODUCTS

2.01 GRAVEL

A. Gravel shall conform to the requirements of Section 310000 - EARTHWORK, Gravel.

2.02 DENSE GRADED CRUSHED STONE SUBBASE AND BASE

A. Dense graded crushed stone shall conform to the requirements of Section 310000 - EARTHWORK, Dense-graded Crushed Stone for Subbase and Base.

PART 3 - EXECUTION

3.01 SUBGRADE PREPARATION

A. All subsurface utility construction shall be completed before fine grading is begun.

B. The pavement and curb subgrade shall be fine graded to the location, elevations and cross slope indicated on the Drawings, using gravel for final adjustments.

C. Subgrades in in-situ soils in both excavation areas and embankment areas shall be compacted during fine grading to 90 percent of maximum dry density in conformance with Section 310000 – EARTHWORK.

3.02 SUBBASE MATERIAL PLACEMENT

A. Subbase material shall not be placed until the Engineer has approved the fine grading, compaction and, condition of the subgrade.

B. Subbase material shall be placed and spread on the approved subgrade in layers not exceeding eight inches (8") in thickness by approved self-spreading equipment. Any displacement of the compacted subgrade material by the equipment shall be restored to the required grade and recompacted before placement of the subbase material.

C. Subbase material shall be compacted to 95 percent of maximum dry density in conformance with Section 310000 – EARTHWORK.

D. The surface of the subbase material shall be fine graded to the location, elevations, and cross slope indicated on the Drawings during final compaction operations.

3.03 BASE MATERIAL PLACEMENT

A. Base material shall not be placed until the Engineer has approved the fine grading, compaction, and condition of the subbase material.

B. Base material shall be spread on the approved subbase in layers not exceeding four inches (4") in thickness by approved self-spreading equipment. Any displacement of the subbase material by equipment shall be restored to the required grade and recompacted before placement of the base material.

C. Base material shall be compacted to 95 percent of dry density in conformance with Section 310000 - EARTHWORK.

D. The surface of the base material shall be fine graded to the proposed location, elevations, and cross slope shown on the Drawings during final layer compaction operations.

END OF SECTION 321100

SECTION 321216

BITUMINOUS PAVING

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 bituminous paving as shown on the drawings and/or specified herein, including but not necessarily limited to the following:

1. Hot-mixed asphalt paving over prepared subbase and pavement marking.
2. Bonded gravel paving.
3. Patching of existing asphalt paving.
4. Pavement markings.
5. Precast concrete car stops.

1.3 RELATED SECTIONS

A. Earthwork - Section 312300, for aggregate subbase and base courses.

B. Concrete curbs - Section 321313.

1.4 DEFINITIONS

A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

B. NYS DOT: New York State Department of Transportation.

1.5 SYSTEM DESCRIPTION

A. Provide hot-mix asphalt paving according to materials, workmanship, and other applicable requirements of Standard Specifications of the NYS DOT.

1. Standard Specification: Hot-mix asphalt paving shall conform to Section 400 Bituminous Pavements of the NYS DOT Standard Specifications and as amended.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who has completed hot-mix asphalt paving similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

B. Manufacturer Qualifications: A qualified manufacturer. Manufacturer shall be a paving-mix manufacturer registered with and approved by authorities having jurisdiction or the NYS DOT.

C. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated, as documented according to ASTM E 548.

D. Regulatory Requirements: Comply with Hot-mix Asphalt Paving as per Section 400 Bituminous Pavements of the NYS DOT Standard Specifications and as amended.

E. Asphalt-Paving Publication: Comply with AI MS-22, "Construction of Hot Mix Asphalt Pavements," unless more stringent requirements are indicated.

F. Preinstallation Conference: Conduct conference at Project site to comply with requirements related to asphalt paving including, but not limited to, the following:

1. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.

2. Review condition of substrate and prepatory work performed by other trades.

3. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.

4. Review and finalize construction schedule for paving and related work. Verify availability of materials, paving Installer’s personnel and equipment required to execute the Work without delays.

5. Review inspection and testing requirements, governing regulations and proposed installation procedures.

6. Review forecasted weather conditions and procedures for coping with unfavorable conditions.

1.7 SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

B. Color samples, 12" x 12".

C. Job-Mix Designs: Certification prior to mixing at any bituminous mixing plant, signed by the material Producer and the Contractor certifying that each material complies with the specified requirements.

D. Qualification Data: For firms and persons specified in the "Quality Assurance" Article 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.

E. Material Test Reports: Indicate and interpret test results for compliance with Section 400 Bituminous Pavements of the Standard Specifications.

F. Material Certificates: For each paving material, signed by manufacturers.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp or if the following conditions are not met:

1. Prime and Tack Coats: Minimum surface temperature of 60 deg F (15.5 deg C).

2. Asphalt Base Course: Minimum surface temperature of 40 deg F (4 deg C) and rising at time of placement.

3. Asphalt Surface Course: Minimum surface temperature of 50 deg F at time of placement.

B. Pavement Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg. F. for oil-based materials, 50 deg. F. for water-based materials, and not exceeding 95 deg. F.

PART 2 PRODUCTS

2.1 BASE COURSE

A. All hot-mix asphalt shall be constructed on a dense graded coarse aggregate base course.

2.2 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Coarse Aggregate: ASTM D 692, sound; angular crushed stone, crushed gravel, or properly cured, crushed blast-furnace slag, in accordance with NYS DOT standards.

C. Fine Aggregate: ASTM D 1073, sharp-edged natural sand or sand prepared from stone, gravel, properly cured blast-furnace slag, or combinations thereof, in accordance with NYS DOT standards.

1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

D. Mineral Filler: ASTM D 242 rock or slag dust, hydraulic cement, or other inert material, in accordance with NYS DOT standards.

2.3 ASPHALT MATERIALS

A. Bituminous Materials: Type and grade of bituminous materials shall be as specified in Table 401-1 of the NYS DOT Standard Specifications.

B. Tack Coat: ASTM D 977 emulsified asphalt or ASTM D 2397, cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

C. Water: Potable.

D. Color: As selected by Landscape Architect.

2.4 MIXES

A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes conforming to NYS DOT standards designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types", and complying with the following requirements.

1. Top Course: NYS DOT Type 7F: 6 to 8 percent of asphalt.

2. Binder Course: NYS DOT Type 3: 4.5 to 6.5 percent asphalt.

2.5 PAVEMENT MARKINGS

A. Pavement Marking Paint: Factory-mixed, quick-drying non-bleeding paint specifically formulated for marking asphaltic concrete surfaces, white color equal to "Setfast Acrylic Waterborne Traffic Marking Paint (TM226)" made by Sherwin Williams or approved equal.

2.6 PRECAST CONCRETE CAR STOPS

A. Provide 3500 psi air entrained pre-cast concrete car stops with absorption rates not exceeding 5% and smooth finish. Stops shall be 6'-0" long, 7" wide by 7" high and reinforced with two 7/8" diameter deformed bars conforming to ASTM A 615, grade 60. Stops shall be anchored with three (3) 1-1/4" diameter galvanized steel pipe, 2'-0" long. Concrete materials shall conform to the requirements of Section 033000.

2.7 FORMWORK AND EXPANSION JOINT FILLER

A. Provide "Homex 300" by Homasote Company, or approved equal, and complying with ASTM D 1751, AASHTO Designation M213-65 and ICC-ES ESR-1374.

2.8 JOINT SEALANTS

A. Joint sealants and fillers at paving terminations and edges.

B. Color(s): As selected and approved by the Landscape Architect.

2.9 EQUIPMENT

A. Paving Equipment: Spreading, self-propelled asphalt paving machines capable of maintaining line, grade, and thickness shown.

B. Compacting Equipment: Self-propelled rollers, minimum 10 ton weight.

C. Hand Tools: Rakes, shovels, tampers, and other miscellaneous equipment required to complete the work.

D. Pavement Marking Equipment: Provide spray machines specifically designed for pavement marking.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions where bituminous pavement 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.

1. Verify that subgrade is dry and in suitable condition to support paving and imposed loads.

2. Verify gradients and elevations of subbase are correct.

3. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.

4. Proceed with paving and patching and repairs only after unsatisfactory conditions have been corrected.

3.2 REPAIRS AS REQUIRED

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.

1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.

B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch.

1. Clean cracks and joints in existing hot-mix asphalt pavement.

2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

3. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

3.3 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

1. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.

B. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.

2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillage and clean affected surfaces.

3.4 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt binder course in number of lifts and thicknesses indicated.

2. Place hot-mix asphalt surface course in single lift.

3. Spread mix at minimum temperature of 250 deg F.

4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes, unless otherwise indicated.

5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

D. For thickness of each course, conform to the following, unless otherwise shown on drawings:

1. Aggregate Base: 6" thick.

2. Asphaltic Binder Course: 5" thick.

3. Asphaltic Top Course: 3" thick.

3.5 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.

2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.

3. Offset transverse joints, in successive courses, a minimum of 24 inches.

4. Construct transverse joints as described in AI MS-22, "Construction of Hot Mix Asphalt Pavements."

5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.

6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.6 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 97 percent of reference laboratory density according to ASTM D 1559.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.7 INSTALLATION TOLERANCES

A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch

2. Surface Course: Plus 1/4 inch, no minus

B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch

2. Surface Course: 1/8 inch

3.8 PAVEMENT MARKING

A. Do not apply pavement marking paint until layout, colors, and placement have been verified with Architect.

B. Sweep and clean surface to eliminate loose material and dust.

C. Apply paint with mechanical equipment to produce pavement markings of dimensions indicated with uniform, straight edges. Apply at manufacturer’s recommended rates to provide a minimum wet film thickness of 15 mils.

3.9 CAR STOPS

A. Install car stops in locations noted exposed evenly between parking stalls. Hold stop securely in place by pouring haunch with three embedded pipe anchors for each stop. Anchors shall be set flush with top of stop.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: The Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and to prepare test reports.

1. Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from specified requirements.

B. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

C. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

D. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

E. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979.

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.11 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow excavated materials to accumulate on site.

END OF SECTION

SECTION 321313

PORTLAND CEMENT CONCRETE PAVEMENT

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 Portland cement concrete pavement as shown on the drawings and/or specified herein, including, but not necessarily limited to, the following:

1. Concrete curbs and walks.

2. Reinforcement.

3. Joint fillers.

1.3 RELATED SECTIONS

A. Concrete - Section 033000.

B. Prepared sub-base - Section 312300.

1.4 SYSTEM DESCRIPTION

A. Provide Portland cement concrete paving according to materials, workmanship, and other applicable requirements of Standard Specifications of the NYS DOT.

1. Standard Specification: Portland cement concrete paving shall conform to Section 500 Portland Cement Concrete of the NYS DOT Standard Specifications and as amended.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Installations of work specified in this section shall be by firm(s) which can exhibit proof of a minimum of twenty years prior successful experience with installations of equivalent type and similar scope of this Project.

1. Foreman: Installation firm for work of this Section 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 20 years total installation experience and with at least 10 years experience in installations of equivalent or more extensive type and scope to this Project. Submit detailed resume of past experience with dates, duration and scope identification, Project Name and location, and work function of previous projects worked on.

2. 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 specific requirements and methods needed for performance of the work of this Section.

1.6 SUBMITTALS

A. Submit test reports and materials certification as required in Section 033000.

B. Samples: Joint Filler, 12" long, in color as selected and approved by the Landscape Architect.

PART 2 PRODUCTS

2.1 FORMS

A. Provide steel or wood of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects.

B. Use flexible spring steel forms or laminated boards to form radius bends.

2.2 REINFORCEMENT

A. Provide welded wire mesh conforming to ASTM A 185, 6 x 6, ten gauge.

2.3 CONCRETE

A. Concrete Materials

1. Comply with the applicable requirements of Section 033000.

2. All concrete work of this Section shall contain five percent to seven percent entrained air and shall be air entrained with "Air-Mix" air entraining agent by Euclid Chemical Company or approved equal by Master Builders or Grace. Agent shall conform to ASTM C 260 and shall be mixed with concrete in accordance with manufacturer's instructions.

B. Concrete Mix, Design and Testing: Comply with applicable requirements of Section 033000 for concrete mix design, sampling and testing, and quality control, and as herein specified. Design the mix to produce standard-weight concrete consisting of Portland cement, aggregate, air-entraining admixture and water to produce the following properties:

1. Compressive Strength: Five thousand psi, minimum at twenty-eight days, with a water cement ratio not to exceed 0.45 by weight.

2. Slump Range: Two inches to four inches.

3. Air Content: Five percent to seven percent.

2.4 JOINT SEALANTS AND FILLERS

A. Subject to compliance with ASTM C 920, Type M, Grade P, Class 25 Use T, provide one of the following or approved equal:

1. “Sikaflex-2CNS” by Sika Corporation.

2. “Sonolastic SL2” (slope grade) by Sonneborn Building Products Div., ChemRex, Inc.

3. “Vulkem 245/255” by Tremco Inc.

B. Backer Materials: Provide joint-sealant backer materials that are closed cell, non-absorbent and non-staining; are compatible with joint substrates, sealants, primers, and other joint

fillers; and are approved for applications indicated by joint sealant manufacturer based on field experience and laboratory testing.

1. Backer Strips for Sealants: ASTM D 5249, Type 2, of thickness and width required to control sealant depths, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

C. Gasket: For joint fillers in concrete work, provide closed cell extruded neoprene gasket conforming to ASTM C 509, Grade 4, black.

D. Back-up rod for sealant shall be "Ethafoam" by Dow Chemical Co. or approved equal.

2.5 CURING

A. Cure concrete with "Kurez W VOX" curing compound conforming to ASTM C 309 and Fed. Spec. TT-C-800A, modified with thirty (30) percent solids, as manufactured by the Euclid Chemical Company or equal made by Master Builders, Grace or approved equal.

2.6 WATER REDUCING MIXTURE

A. Provide "Eucon WR-75" water reducing and densifying admixture, by Euclid Chemical Company or equal by Master Builders, Grace, or approved equal. The admixture shall conform to ASTM C 494, Type A, and not contain any lignosiliconates nor more than one percent chloride ions.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions under which concrete walks and curbs 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 SURFACE PREPARATION

A. Remove loose material from the compacted sub-base surface immediately before placing concrete.

B. Proof roll prepared sub-base surface to check for unstable areas and the need for additional compaction. Do not begin paving work until such conditions have been corrected and are ready to receive paving.

3.3 FORM CONSTRUCTION

A. Set forms to the required grades and lines, rigidly braced and secured. Install sufficient quantity of forms to allow continuous progress of the work and so that forms can remain in place at least twenty-four hours after concrete pavement.

B. Check completed formwork for grade and alignment to the following tolerances:

1. Tops of forms not more than 1/8" in ten feet.

2. Vertical face on longitudinal axis, not more than 1/4" in ten feet.

C. Clean forms after each use and coat with form release agent as often as required to ensure separation from concrete without damage.

3.4 REINFORCEMENT

A. Locate, place, and support reinforcement as specified in Section 033000.

3.5 CONCRETE PLACEMENT

A. Comply with the requirements of Section 033000 for mixing and placing concrete.

B. Do not place concrete until sub-base and forms have been checked for line and grade. Moisten sub-base if required to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around manholes or other structures until they are at required finished elevation and alignment.

C. Placing Concrete

1. Place concrete using methods that prevent segregation of the mix. Consolidate concrete along the face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square faced shovels for hand spreading and consolidation.

2. Deposit and spread concrete in a continuous operation between transverse joints, as far as possible. If interrupted for more than 1/2 hour, place a construction joint.

D. Curbs: Automatic machine may be used for curb placement. If machine placement is to be used, submit revised mix design and laboratory test results that meet or exceed the minimums herein specified. Machine placement must produce curbs to the required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not acceptable, remove and replace with formed concrete.

3.6 JOINTS

A. Construct expansion, weakened plane (contraction), and construction joints true to line with face perpendicular to surface of the concrete. Construct transverse joints at right angles to the centerline.

B. Weakened Plane Joints: Provide weakened plane (contraction) joints, sectioning concrete into areas as shown on the Drawings. Construct weakened plane joints for a depth equal to at least 1/4 concrete thickness.

C. Construction Joints: Place construction joints at the end of all pours and at locations where placement operations are stopped for a period of more than 1/2 hour, except where such pours terminate at expansion joints. Use standard metal keyway section forms.

D. Expansion Joints

1. Provide premolded joint filler for expansion joints abutting concrete curbs, catch basins, manholes, inlets, structures, walks, and other fixed objects, unless otherwise indicated.

2. Locate expansion joints at thirty feet on center for each pavement lane, unless otherwise indicated.

3. Extend joint fillers full width and depth of joint, and not less than 1/2" or more than one inch below finished surface where joint sealer is required. If no joint sealer required, place top of joint filler 1/8" below finished concrete surface.

4. Furnish joint fillers in one-piece lengths for the fill width being placed wherever possible. Where more than one length is required, adhere joint filler sections together.

5. Protect the top edge of the joint filler during concrete placement with a metal cap or other temporary material. Remove protection after concrete has been placed on both sides of joint.

6. Fillers and Sealants: Apply sealant over expansion joint where occupied space occurs below the walk. Comply with the requirements of ASTM C1193 and manufacturer for preparation of joints and installation, including priming of joints and backer rod.

3.7 CONCRETE FINISHING

A. After consolidating and striking off concrete, level the surface by darbying or bull floating. After the concrete has stiffened sufficiently to permit the operation and the surface sheen has disappeared, the surface shall be floated. Use hand methods only where mechanical floating is not possible. Adjust the floating to compact the surface and produce a uniform texture.

B. After floating, test surface for trueness with a ten feet long straight edge. Distribute concrete as required to remove surface irregularities, and refloat repaired areas to provide a continuous smooth finish.

C. Work edges of slabs, gutters, back top edge of curb, and formed joints with an edging tool, and round to 1/2" radius, unless otherwise indicated. Eliminate any tool marks on concrete surface.

D. After completion of floating and when excess moisture or surface sheen has disappeared, complete surface finishing by drawing a fine hair broom across concrete surface, perpendicular to line of traffic from full edge to edge. There shall be no border. Repeat operation if required to provide a fine line texture acceptable to the Landscape Architect.

E. Do not remove forms for twenty-four hours after concrete has been placed. After form removal, clean ends of joints and point up any minor honeycombed areas. Remove and replace areas or sections with major defects, as directed by the Landscape Architect.

3.8 CURING

A. Protect and cure finished concrete paving, complying with applicable requirements of Section 033000. Use curing compound specified herein applied in accordance with manufacturer's instructions.

3.9 REPAIRS AND PROTECTION

A. Repairs: Where pavement has been cracked or damaged, remove the entire panel wherein the damage occurs and install a new panel of pavement. No patching within a panel is permitted.

B. Protection

1. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least fourteen days after placement. No construction traffic is permitted.

2. Sweep concrete pavement and wash free of stains, discolorations, dirt, and other foreign material just prior to final inspection.

END OF SECTION

SECTION 321314

EXPOSED AGGREGATE CONCRETE PAVEMENT

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 exposed aggregate concrete pavement as shown on the drawings and/or specified herein, including, but not necessarily limited to, the following:

1. Exposed aggregate concrete paving work.

1.3 RELATED SECTIONS

A. Cast-in-Place Concrete - Section 033000.

B. Clearing and Grubbing - Section 311100.

C. Site Excavating, Backfilling and Compacting - Section 312300.

D. Portland Cement Concrete Pavement - Section 321313.

E. Granite Curb - Section 321640.

1.4 SYSTEM DESCRIPTION

A. Provide exposed aggregate concrete paving according to materials, workmanship, and other applicable requirements of Standard Specifications of the NYS DOT.

1. Standard Specification: Portland cement concrete paving shall conform to Section 500 Portland Cement Concrete of the NYS DOT Standard Specifications and as amended.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94/C 94M requirements for production facilities and equipment

B. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.

C. ACI Publications: Unless otherwise specified, work and materials for construction of the Portland cement concrete paving shall conform to ACI 325.9R.

D. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

E. Paving work, base course etc., shall be done only after excavation and construction work which might injure them have been completed. Damage caused during construction shall be repaired before acceptance.

F. Existing paving areas shall, if damaged or removed during course of this project, be repaired or replaced under this section of the specification. Workmanship and materials for such repair and replacement, except as otherwise noted, shall match as closely as possible those employed in existing work.

G. Pavement, base, or subbase shall not be placed on a muddy or frozen subgrade.

H. Testing and Inspection: The Owner reserves the right to test and inspect materials and construction of crushed stone surfacing in accordance with the requirements of Section 014523 "Testing and Inspection."

I. Mock-Up

1. General

a. Schedule mock-up casting for acceptance 30 days prior to casting of concrete surfaces represented by the mockups.
b. Locate mock-up panels in non-public areas accepted by the Architect.
c. Continue to cast mock-ups until acceptable mock-ups area produced. Accepted mock- ups shall be the standard for color, texture, and workmanship for the work.
d. Mock-up sequence of forming, placing, form removal, curing, and finishing shall be reviewed and accepted by the Architect.
e. Mock-up formwork shall be inspected and accepted by the Architect before placing of concrete.
f. Use the same concrete mixes and placement procedures, accepted in mock-ups, in the final work, unless otherwise directed by the Architect.
g. Protect accepted mock-ups from damage until completion and acceptance of the work represented by the mock-up.
h. Remove mock-up panels from site at completion of project, as directed by the Architect.

2. Construct mock-up panels or areas as indicated to demonstrate the ability to cast concrete for concrete paving to achieve shape, color, and ground/sandblast textured finish required. Mock-ups shall include or meet the following requirements:

a. Provide full scale mock-up panels and areas.
b. Provide mock-ups simulating actual design and execution conditions for concrete mix materials, reinforcement, formwork, placing sequence, form removal, curing, finishing, and methods and materials of stain removal and correction of defective work.
c. On mock-ups where directed by the Architect, provide minimum of three variation of mix color to be used in the repair of defective work, in order to determine acceptable color and texture match.
d. Demonstrate in the construction of the mock-up formwork the sealer material, form release agent, and curing materials and methods to be used.

3. Source of Materials: Use the same source, stock, or brand of stabilizer material for all decomposed granite surfacing. Do not interchange materials or mixes until an additional mock-up shows that uniformity in finish texture and color, as compared to original mock-up will be maintained. If necessary, obtain and stockpile materials in sufficient quantity to ensure continuity and uniformity.

1.6 SUBMITTALS

A. Description of Methods and Sequence of Placement. For each type of specially-finished concrete provide description of methods and sequence of placement.

B. Manufacturers' product data shall be submitted for the following items:

1. Admixtures.

2. Aggregate, including sieve analysis.

3. Concrete sealer.

4. Curing material.

5. Preformed joint filler.

6. Form release agent.

7. Sealants.

C. Shop drawings of exposed aggregate paving shall be submitted. Drawings shall indicate expansion joint, control joint and decorative joint locations.

D. Samples: Submit samples of the following:

1. Preformed joint filler, two pieces, full depth and width, 4 in. length.

2. Color chart for selection of sealant color.

3. A 10 lb. minimum sample of aggregate proposed for use on the exposed aggregate paving shall be submitted for approval. Accompanying the sample shall be information from the aggregate supplier indicating source, type, color, and gradation of aggregate. Aggregate shall be 3/8”-1/2” Crushed Bluestone, supplied by Gault Stone, Bridgeport CT.

1.7 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

1.8 DESIGN OF CONCRETE MIX

A. The Contractor shall be responsible for the design of the concrete mixture. Mix design shall be certified by an independent testing laboratory. The statement of materials constituting the design mix shall be submitted to the Architect for approval within one week following award of Contract. The concrete mix design shall include the following information:

1. Proportions of cement, fine and coarse aggregates, and water.

2. Water-cement ratio, design strength, slump, and air content.

3. Type of cement.

4. Type of aggregates including sieve analysis.

5. Type and dosage of all admixtures.

6. Special requirements for pumping.

7. Range of ambient temperature and humidity for which the design is valid.

8. Any special characteristics of the mix which require precautions in the mixing, placing, finishing, or curing methods to achieve the finished product specified.

B. No concrete shall be delivered to the job site until the Architect has reviewed and approved the design mix.

PART 2 PRODUCTS

2.1 AGGREGATE BASE COURSE

A. Refer to Section 312300, SITE EXCAVATING, BACKFILLING AND COMPACTING

2.2 FORMWORK

A. Formwork: The dimensions of the lumber used to form concrete pavements shall not be less than 2" (nominal thickness) by the required pavement depth.

B. Forms for Unexposed Finish: Plywood, lumber or metal, with lumber dressed on at least two edges and one side.

C. Form Coatings: Commercial formulation compounds that will not bond with, stain or adversely affect concrete.

D. Forms shall be true to line and free from warp, and shall be of sufficient strength, when staked, to resist the pressure of the concrete without springing. Formwork shall be designed so that sections may be fastened together to prevent vertical or horizontal movement of ends.

2.3 STEEL REINFORCEMENT

A. Steel reinforcing bars shall conform to the following requirements:

1. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420); deformed.

B. Welded wire fabric reinforcement shall conform to the following applicable requirements. Fabric reinforcement shall be furnished in flat sheets. Fabric reinforcement in rolls will not be permitted.

1. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

2. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet.

C. Joint Dowel Bars: Plain steel bars, ASTM A 615/A 615M, Grade 60 (Grade 420). Cut bars true to length with ends square and free of burrs.

D. Tie Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete.

2.4 CONCRETE

A. Concrete to receive an exposed-aggregate surface shall contain a minimum of 610 lb. of cementitious material content per cubic yard of concrete, and a water-cement ratio no greater than 0.53 by weight. Minimum compressive strength shall be 4,500 psi at 28 days. Supplementary Cementitious Materials to be limited as required for Concrete Assigned to Exposure Class F3 as Defined by ACI 318.

B. Maximum slump shall not exceed 4 in. and air entrainment shall be 7 percent ± 1 percent.

C. Maximum size of coarse aggregate of the base mix shall be 1/2 in.

D. Ready mixed concrete, if used, shall meet ASTM C 94.

E. An oversanded base mix may be used, and if so, the water-cement ratio specified above shall govern the mix design, and the cement content shall be raised accordingly. Aggregate source and cement type and brand shall not be altered once construction begins.

2.5 CHEMICAL ADMIXTURES

A. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.

2. Retarding Admixture: ASTM C 494/C 494M, Type B.

2.6 AGGREGATE

A. Aggregate to be exposed shall be hard, sound, durable peastone, and free of all deleterious materials and staining qualities.

B. The select aggregate shall be stored off the ground and protected from contamination and moisture.

C. Aggregate shall match Architect-approved sample.

D. Peastone aggregate shall be of one sieve size or no more than two.

E. Shape of aggregate shall resemble spheres and cubes. Flat, slivery stones that may become dislodged easily shall not be used.

2.7 CLEANER

A. Chemically neutral cleaner with pH factor between 7 and 10 that is biodegradable, phosphate free, and recommended by cleaner manufacturer for use on exposed aggregate pavement type indicated.

2.8 SEALER

A. Sealer shall be a methyl methacrylate acrylic resin suitable for sealing of exposed aggregate horizontal concrete surfaces. Sealer shall be subject to the approval of the Architect.

B. Sealer shall be Enviroseal 20, manufactured by Hydrozo, or approved equal.

2.9 CURING MATERIALS

A. Curing shall be by moist curing or by use of curing compound.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry.

C. Moisture-Retaining Cover: Curing paper shall be nonstaining, fiber reinforced laminated kraft bituminous product conforming to ASTM C 171. Four mil polyethylene sheeting may be substituted for curing paper.

D. Curing compound shall be a resin-base, white pigmented compound conforming to ASTM C 309, Type 2.

E. Water: Potable.

2.10 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M [and ASTM C 1116]. Furnish batch certificates for each batch discharged and used in the Work.

B. When air temperature is between 85 deg F (30 deg C) and 90 deg F (32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

C. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.

2.11 EXPANSION JOINTS

A. Expansion joints shall be located as indicated on the Drawings

B. Expansion joints shall be 3/8” wide. Expansion joint filler shall be flexible foam expansion joint filler composed of a unique synthetic foam of isomeric polymers in a very small, closed-cell structure conforming to ASTM D 1752, similar to Ceramar Flexible Foam Expansion Joint Filler, manufactured by W.R. Meadows, Inc., or preformed, nonbituminous type joint filler conforming to ASTM D 1752, Type II, similar to Sealtight Cork or Self-Expanding Cork Expansion Joint Filler, manufactured by W.R. Meadows, Inc., or approved equal.

a. Premolded filler shall be one piece for the full depth and width of the joint.

b. Use of multiple pieces of lesser dimensions to make up required depth and width of joint will not be permitted.

c. Except as otherwise noted on the Drawings, joint filler shall be 3/8 in. thick.

d. Doweled at each expansion joint. One end of the dowel shall be greased.

C. Where indicated, concrete slab-on-grade shall be doweled at each expansion joint. One end of the dowel shall be greased.

D. Round Expansion Joint Dowels: ASTM A615, Grade 60, epoxy-coated, smooth, billet-steel bars, clean and free of rust and scale.

E. Dowel Caps for Round Dowels: Plastic caps approximately 4" long, designed and manufactured to fit over ends of expansion joint dowels to allow longitudinal movement of dowels after concrete has hardened.

F .Dowel Aligners for Round Dowels: PNA Dowel Aligners, or accepted substitute.

G. Snap Cap, manufactured by W.R. Meadows, Inc., or approved equal.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions under which exposed aggregate concrete paving 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 GRADING

A. Areas to be paved will be compacted and brought approximately to subgrade elevation under Section 312300, SITE EXCAVATING, BACKFILLING AND COMPACTING before work of this section is performed. Final fine grading, filling, and compaction of areas 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. Subgrade shall be compacted as required to bring the top 6 in. of subgrade material immediately below the concrete pavement to a density of not less than 97 percent at optimum moisture content as determined by ASTM D 698. Subgrade compaction shall extend for a distance of at least 1 ft. beyond edge of pavement.

1. 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 at optimum moisture of at least 95% density, as determined by ASTM D 698. Subgrade compaction shall extend for a distance of at least 1 ft. beyond pavement edge.

D. Excavation required in pavement subgrade shall be completed before fine grading and final compaction of subgrade are performed. 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 pavement.

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 conform to the following.

1. Material shall be legally disposed of off-site.

H. Subgrade shall be kept clean and uncontaminated. Portions of subgrade which becomes contaminated, softened, or dislodged by passing of traffic, or otherwise injured, shall be cleaned, replaced, or otherwise repaired to conform to the requirements of this specification before proceeding with next operation.

I. Prepared subgrade will be inspected by the Architect. Subgrade shall be approved by the Architect before installation of gravel base course. Disturbance to subgrade caused by inspection procedures shall be repaired under this section of the specification.

3.3 AGGREGATE BASE COURSE

A. Refer to Section 312300, SITE EXCAVATING, BACKFILLING AND COMPACTING

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. 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 smooth drum vibratory roller equivalent to a 6 ton static roller, or an approved equivalent. Smaller areas or areas impossible to reach with large drum rollers shall be compacted to specified density using a vibrating plate compactor.

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. as measured by means of a 10 ft. long straightedge, shall be replaced and properly recompacted.

D. Base course shall be compacted at optimum moisture content to not less than 95% of maximum density as determined by ASTM D 1557.

E. 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.

F. Portions of subgrade or of construction above which become contaminated, softened, or dislodged by passing of traffic, or otherwise injured, shall be cleaned, replaced, or otherwise repaired to conform to the requirements of this specification before proceeding with next operation.

3.4 STEEL REINFORCEMENT

A. Before being placed in position, reinforcing for reinforced concrete shall be thoroughly cleaned of loose mill and rust scale, dirt, ice, and other foreign material which may reduce the bond between the concrete and reinforcing. Where there is delay in placing concrete after reinforcement is in place, bars shall be reinspected and cleaned when necessary.

B. Unless otherwise indicated on the Drawings, reinforcing shall extend within 2 in. of formwork and expansion joints. Reinforcing shall continue through control joints. Adjacent sheets of fabric reinforcing shall lap 6 in.

C. After forms have been coated with form release agent, but before concrete is placed, reinforcing steel anchors shall be securely wired in the exact position called for, and shall be maintained in that position until concrete is placed and compacted. Chair bars and supports shall be provided in a number and arrangement satisfactory to the Architect.

3.5 CONCRETE PLACEMENT

A. Paving mix, equipment, methods of mixing and placing, and precautions to be observed as to weather, condition of base etc., shall meet the requirements of ACI 325. Pavement shall be constructed in accordance with the Drawings.

B. The Architect shall be notified of concrete placement sufficiently in advance of start of operation to allow his representative to complete preliminary inspection of the work, including subgrade, forms, and reinforcing steel, if used.

C. Normal concrete placement procedures shall be followed. Concrete shall arrive at the jobsite so that no additional water will be required to produce the desired slump. When conditions develop that require addition of water to produce the desired slump, permission of the Architect must be obtained. The concrete shall be transported from the mixer to its place of deposit by a method that will prevent segregation or loss of material. Concrete shall be placed in accordance with ACI 304.

D. Concrete shall be consolidated by suitable means to eliminate voids and pockets.

E. The strike-off and darby or bullfloat operations should be such that a level surface is obtained sufficiently below the final finish grade to allow for volume growth due to the addition of the seeding aggregate.

F. Expansion joints shall be formed in the concrete to required width with preformed joint filler in place. Depth of filler shall be as required to form a 5/8 in. deep sealant and backer rod recess below finished surface of walkway.

3.6 COLD WEATHER CONCRETING

A. Materials for concrete shall be heated when concrete is mixed, placed, or cured when the mean daily temperature is below 40oF. or is expected to fall to below 40 degrees F within 72 hours, and the concrete after placing shall be protected by covering, heat, or both.

B. Details of handling and protecting of concrete during freezing weather shall be subject to the approval and direction of the Architect. Procedures shall be in accordance with provisions of ACI 306R.

3.7 HOT WEATHER CONCRETING

A. Concrete just placed shall be protected from the direct rays of the sun and the forms and reinforcement just prior to placing shall be sprinkled with cold water. Every effort shall be made to minimize delays which will result in excessive mixing of the concrete after arrival on the job.

B. During periods of excessively hot weather (95oF., or above), ingredients in the concrete shall be cooled insofar as possible and cold mixing water shall be used to maintain the temperature of the concrete at permissible levels all in accordance with the provisions of ACI 305R. Any concrete with a temperature above 95oF., when ready for placement will not be acceptable, and will be rejected.

C. Temperature records shall be maintained throughout the period of hot weather giving air temperature, general weather conditions (calm, windy, clear, cloudy, etc.) and relative humidity. Records shall include checks on temperature of concrete as delivered and after placing in forms. Data should be correlated with the progress of the work so that conditions surrounding the construction of any part of the structure can be ascertained.

3.8 SEEDED EXPOSED-AGGREGATE FINISH

A. Prior to the concrete placing operation, all select seeding aggregate shall be washed thoroughly so that it is free of all dust, dirt, and clay particles. The aggregate shall be in a damp condition but without free surface water at the time of seeding application. There shall be sufficient select aggregate on hand to complete the seeding once it has started.

1. Work shall be planned so that the concrete-placing and aggregate-seeding procedures are coordinated with the capabilities of the washing and brushing crew.

B. The seeding operation shall start immediately after the placement of concrete as described above. The select aggregate shall be carefully and uniformly seeded by suitable means so that the entire surface is completely covered with one layer of stone. Stacked stone and flat and slivery particles shall be removed at this time. The aggregate shall be embedded by suitable means, and float finished to entirely embed aggregate with mortar cover of 1/16 inch (1.6 mm). Care shall be taken not to overembed and deform the surface. Under no circumstances shall areas lacking sufficient mortar be filled with small quantities of the base concrete mix.

1. Spray-apply chemical surface retarder to pavement according to manufacturer's written instructions.

2. Cover pavement surface with plastic sheeting, sealing laps with tape, and remove sheeting when ready to continue finishing operations.

3. Without dislodging aggregate, remove excess mortar by lightly brushing surface with a stiff, nylon-bristle broom.

4. Fine-spray surface with water and brush. Repeat water flushing and brushing cycle until cement film is removed from aggregate surfaces to depth required.

3.9 CONSTRUCTION JOINTS

A. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour unless pavement terminates at isolation joints.

1. Continue steel reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.

2. Provide tie bars at sides of pavement strips where indicated.

3. Butt Joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.

5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.10 EXPANSION JOINTS

A. Expansion joints shall be placed where pavement meets curbing or structures, including light bases, hydrants and at other conditions as shown on the Drawings.

1. Place expansion joints twenty feet (20') on center and/or as indicated on the Drawings. Follow the manufacturer's application recommendations for joint filler and sealer. Expansion joints shall be on-half inch (1/2") wide. Joint alignment shall be straight and true.

2. Clean joint surfaces immediately before application of primer and installation of sealant or caulking compound. Remove dirt, insecure coatings, moisture and other substances which interfere with bond of sealant. Do not proceed unless all joint surfaces are completely dry. Use primer for joints as recommended by sealant manufacturer.

B. Install expansion dowels and sleeves perpendicular to and across all expansion joints in the concrete paving at two feet (2') on center minimum, or as shown on the Drawings.

1. Forms shall not be moved for 72 hours after the concrete has been placed, or for a longer period if directed by the Engineer. Extreme care shall be taken in removing forms in order that no damage will be done to the concrete. Under no condition shall any bar, pick or other tool be used which depends upon leverage on the concrete for removal of the forms.

3.11 CONTROL JOINTS

A. Control joints indicated shall be sawn by using a special soff-type early entry concrete power saw. Joint shall be made after concrete is finished and when the surface is stiff enough to support the weight of workmen without damage to the slab. Saw shall cut into slab at least 1 in., but in no case less than 25% of slab depth.

B. Sawing shall cut into slab surface at least 1 in., but in no case not less than 25% of slab depth.

1. Sawed Joints: Form joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

3.12 DECORATIVE SAW CUT JOINTS

A. Unless otherwise indicated, decorative saw cut joints shall be sawn into the concrete slab using a special soff-type early entry concrete power saw, at intervals and patterns indicated on the Drawings. Joint shall be made after concrete is finished and when the surface is stiff enough to support the weight of workmen without damage to the slab, but before slab has achieved its final set. Saw cut joints shall be straight and accurate to line.

1. Saw cut joints shall be sawn flush to vertical surfaces.

B. Decorative saw cut joints shall be located 16 in. o.c. each way to create scoring patterns indicated on the Drawings.

C. Depth of decorative saw cut joint shall be 3/4 in.

3.13 CURING

A. As soon as the washing operation ceases, the curing operation shall begin. The concrete shall be kept in continuously moist condition by covering with curing paper for 5 days in warm weather (70 deg. F. or higher) or 7 days in cooler weather (50-70 deg. F.). The temperature of the concrete shall not be allowed to fall below 50 deg. F. during the curing period.

B. During periods of excessively hot weather (95oF., or above) ingredients in the concrete shall be cooled insofar as possible and cold mixing water shall be used to maintain the temperature of the concrete at permissible levels all in accordance with the provisions of ACI 305. Any concrete with a temperature above 95oF. when ready for placement will not be acceptable and will be rejected.

3.14 FINISHING

A. Finishing – Ground/Sandblast Finish:

1. Seed additional aggregates in matrix to uniformly distribute granular material on surface.

2. Delay fine grinding until heavy trade work is complete and construction traffic through area is restricted.

3. Fine Grinding: Grind with stones 120 grit or finer until all grout is removed from surface. Repeat rough grinding, grout coat, and fine grinding if large voids exist after initial fine grinding. Produce surface with a minimum of 70 percent aggregate exposure.

4. Sandblast: Provide light sandblast finish following fine grinding operations. Match approved sample panel.

B. Cleaning:

1. Remove grinding dust from installation and adjacent areas.

2. Wash surfaces with cleaner according to manufacturer's written instructions; rinse surfaces with water and allow to dry thoroughly.

3.15 SEALING OF JOINTS

A. Fillers and Sealants: Apply sealant over expansion joint where occupied space occurs below the walk. Comply with the requirements of Section 079200 for preparation of joints and installation, including priming of joints and backer rod.

3.16 SEAL COAT

A. After the slab is washed and is completely dry, the sealer shall be uniformly applied to the surface at the application rate and methods recommended by the sealer manufacturer.

3.17 PROTECTION OF CONCRETE SURFACES

A. Concrete surfaces shall be protected from traffic or damage until surfaces have hardened sufficiently. If necessary, 1/2 in. thick plywood sheets shall be used to protect the exposed surface.

END OF SECTION

SECTION 321543

STABILIZED STONE DUST PAVING

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 stabilized stone dust paving as shown on the drawings and/or specified herein, including, but not necessarily limited to, the following:

1. Stone dust (decomposed granite) paving with stabilizer material, topped with peastone aggregate, including aggregate base and edging.

1.3 RELATED SECTIONS

A. Clearing and Grubbing - Section 311100.

B. Site Excavating, Backfilling and Compacting - Section 312300.

1.4 QUALITY ASSURANCE

A. Crushed granite sample of sufficient quantity shall be submitted to stabilizer manufacturer for recommended blending proportions and procedures to be followed by crushed granite supplier. Blending operations shall be performed at crushed granite supplier facility and provided to Contractor pre-blended in accordance with stabilizer manufacturer's recommendations.

B. Installer shall provide evidence to indicate successful experience in providing crushed granite surfacing containing stabilizer binder/additive or ability to follow installation instructions.

C. Installer shall provide documentation of at least three (3) installations similar in scale (all reference projects to be equal or greater than 75% of the total square footage of the project being bid on) using specified stabilizer solution material, completed over the past five (5) years. If Contractor is not able to meet experience qualifications, Contractor shall be required to have a representative from Stabilizer Solutions be present on site for pre-construction training, installation of mockup, and at least 25% of the project installation. Contractor shall be responsible for any and all costs associated with this requirement. If contractor is unable to meet these requirements a qualified replacement contractor will be located subject to all qualifications listed above and Owner approval.

D. Testing and Inspection: The Owner reserves the right to test and inspect materials and construction of crushed stone surfacing in accordance with the requirements of Section 014523 "Testing and Inspection."

E. Mock-Up

1. General

a. Schedule mock-up for acceptance 30 days prior to constructing decomposed granite surfaces represented by the mockups.
b. Locate mock-up panels in non-public areas accepted by the Architect.
c. Continue to construct mock-ups until acceptable mock-up is produced. Accepted mock-up shall be the standard for color, texture, mix ratio, and workmanship for the work.
d. Use the same decomposed granite /stabilizer mix and placement procedure, accepted in mock-ups, in the final work, unless otherwise directed by the Architect.
e. Protect accepted mock-ups from damage until completion and acceptance of the work represented by the mock-up.
f. Remove mock-up panels from site at completion of project, as directed by the Architect.

2. Sample panel shall be 5 ft. x 5 ft. minimum.

3. Source of Materials: Use the same source, stock, or brand of stabilizer material for all decomposed granite surfacing. Do not interchange materials or mixes until an additional mock-up shows that uniformity in finish texture and color, as compared to original mock-up will be maintained. If necessary, obtain and stockpile materials in sufficient quantity to ensure continuity and uniformity.

1.5 SUBMITTALS

A. Manufacturer's Product Data: Submit Manufacturer's product data for stabilizer.

B. Test Results: Submit test results for stabilized crushed stone surfacing indicating compliance with ADA Requirements for accessibility and slip resistance.

C. Samples: Submit 1 lb. of each item indicated below, for color approval:

1. Decomposed granite.

2. Peastone aggregate topping.

1.6 PERFORMANCE REQUIREMENTS

A. Perform gradation of decomposed granite material or 3/8" or 1/4" minus crushed aggregate in accordance with ASTM C 136 "Method for Sieve Analysis for Fine and Course."

1.7 JOB CONDITIONS

A. Field Measurements: Each bidder is required to visit the site of the Work to verify the existing conditions. No adjustments will be made to the Contract Sum for variations in the existing conditions.

1. Where surfacing is indicated to fit with other construction, verify dimensions of other construction by field measurements before proceeding with the work.

B. Environmental Limitations: Do not install decomposed granite or crushed 3/8" or 1/4" minus aggregate paving during rainy conditions or below 40 degrees F and falling.

1.8 WARRANTY

A. Provide written warranty signed by stabilizer manufacturer, installer, and Contractor, agreeing to repair or replace all work of this section which exhibits defects in materials or workmanship. Warranty shall cover stabilizer, decomposed granite and aggregate base work. "Defects" is defined to include, but not limited to, differential settlement, ponding of water, abnormal aging or deterioration of stabilized paving system, and failure to perform as required.

1. Warranty Period: 90 days from date of Substantial Completion.

2. Contractor shall provide unconditional maintenance and repairs as required through the warranty period.

PART 2 PRODUCTS

2.1 MATERIALS

A. Aggregate Base Course: Refer to Section 312300, SITE EXCAVATING, BACKFILLING AND COMPACTING.

B. Decomposed Granite: Decomposed granite or 3/8 in. or 1/4 in. crushed aggregate screenings.

1. Crushed Stone Sieve Analysis Percentage of Weight Passing a Square Mesh AASHTO T11-82 and T2782. Gradation requirements shall be as follows:

Sieve Size	% Passing by Weight
3/8 in.	100
No. 4	90 - 100
No. 8	75 - 80
No. 16	55 - 65
No. 30	40 - 50
No. 50	25 - 35
No. 100	15 - 20
No. 200	10 - 15

2. Decomposed granite color shall be as selected by the Architect.

C. Stabilizer: Stabilizer additive shall be "Stabilizer", a non-toxic, colorless, odorless, concentrated powder organic binder capable of binding crushed aggregate screenings, manufactured by Stabilizer Solutions, Inc., 33 South 28th Street, Phoenix, AZ 85034; Tel. 602-225-5900; 1-800-336-2468; Fax: 602-225-5902; E-mail: info@stabilizersolutions.com, or approved equal.

1. Material shall be provided by supplier pre-mixed with stone dust (decomposed granite) material specified herein.

D. Peastone Topping Aggregate: Peastone aggregate for topping course shall be washed, rounded 3/8" peastone in color to match Architect's approved sample.

E. Edging: Steel edging shall be Border Concepts Edging, "Border King", manufactured by Border Concepts, Inc., P.O. Box 471185, Charlotte, NC 28247 or approved equal. Steel edging shall be shop fabricated, 1/4 in. thick x 6 in. deep, primed and painted Black. Edging shall be furnished in 16 ft. lengths.

F. Filter Fabric: Filter fabric shall be a non-woven polypropylene fabric equal to Mirafi 140N, manufactured by Tencate, 365 South Holland Drive, Pendergrass, GA 30567; Tel 800 685 9990; Tel 706 693 2226; Fax 706 693 4400; www.mirafi.com, or approved equal.

G. Pre-Emergent Herbicide: Herbicide shall be LESCO Ornamental Herbicide 5G, pre-emergent grassy and selected broadleaf weed control for ornamental plants, nursery stock and ground covers, #019515, manufactured by LESCO, Rocky River, OH 44116; Sierraron, manufactured by Scotts; Preen, manufactured by Lebanon Seaboard Corporation, or approved equal.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions under stabilized stone dust paving 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 GRADING

A. Areas to be paved 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 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. Subgrade compaction shall extend for a distance of at least 1 ft. beyond pavement edge.

D. Excavation required in pavement 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 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 pavement.

F. Materials shall not be stored or stockpiled on subgrade.

G. Contractor shall dispose of, off site, 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.

H. Prepared subgrade will be inspected by the Architect. Subgrade shall be approved by the Architect before installation of paving base course. Disturbance to subgrade caused by inspection procedures shall be repaired under this Section of the specification.

3.3 AGGREGATE BASE COURSE

A. Refer to Section 312300, SITE EXCAVATING, BACKFILLING AND COMPACTING

3.4 FILTER FABRIC

A. Filter fabric shall be placed on compacted subgrade in accordance with manufacturer's printed instructions. Line trench on bottom and up the sides as indicated on the Drawings. Where fabric edges meet, they shall overlap a minimum of 12 in.

3.5 EDGING

A. Install as detailed.

3.6 STONE DUST (DECOMPOSED GRANTE) SURFACING

A. Stabilizer shall be provided thoroughly and unifomly pre-blended with decomposed granite by local supplier, at rate, and by method in strict accordance with manufacturer's printed instructions.

1. Blend 12 to 16-lbs (contact manufacturer for exact blend) of Stabilizer per 1-ton of decomposed granite or crushed aggregate screenings. It is critical that Stabilizer be thoroughly and uniformly mixed throughout decomposed granite or crushed aggregate screenings.

2. Bucket blending is not acceptable. Blending with a rake and or shovel is not acceptable.

3. Blend material dry.

B. Decomposed granite 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.

C. Decomposed granite surfacing shall be constructed on a compacted aggregate base or sand-based structural soil mix as indicated on the Drawings.

D. Pre-blended stabilized decomposed granite or crushed aggregate screenings shall be spread evenly over the base in 1-1/2 in. maximum lifts, rolled and compacted to 85% of maximum density as determined by ASTM D 1557. Final compacted thickness shal be 3 in.

1. Contractor shall wait a minimum of 24 hours after placing stabilized decomposed granite material prior to compaction. Longer periods may be required for material to adequately dry. Consult manufacturer to make determination.

E. Water shall be added to decomposed granite for full-depth moisture penetration prior to compacting.

1. Minimum 25 to 45-gallons of water per 1-ton must be applied to achieve saturation of stabilized pathway profile.

2. During water application randomly test for depth using a probing device, which reaches full depth.

F. Upon thorough moisture penetration, compact stabilized decomposed granite to 85% relative compaction with 2 to 4 ton durable drum roller or 1000 lb. single drum roller as required to achieve a dense, hard packed surface conforming to the finish grades indicated.

1. Do not use vibratory rollers or compactors.

2. Do not begin compaction for 12 hours after placement and up to 72 hours.

3. Contractor shall hand tamp areas adjacent to irrigation or plantings with 8 in. or 10 in. hand tamper.

4. If surface aggregate dries significantly quicker than subsurface material, lightly mist surface before compaction operations.

G. Variations in smoothness of finished stone dust surface shall be less than or equal to 1/4 in. when tested with a 10 ft. straightedge, applied both parallel to and at right angles to centerline of stone dust surface areas. Irregularities exceeding these requirements or that retain water on surface shall be corrected by removing defective work and replacing with new material conforming to this specification.

H. Crushed stone surface shall comply with ADA Requirements for slip resistance and accessibility, with a minimum static coefficient of friction of 0.6 for accessible routes and 0.8 for ramps, when tested in accordance with ASTM C1028.

I. Allow finished surface to dry completely before applying peastone topping.

3.7 PEASTONE TOPPING COURSE

A. Peastone topping course 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. Peastone topping course shall be constructed over stabilized decomposed granite surfacing as indicated on the Drawings.

C. Peastone topping shall be spread evenly over the stabilized decomposed granite surfacing in 1-1/2 in. maximum lifts, rolled and compacted to 85% of maximum density as determined by ASTM D 1557. Final compacted thickness shall be as indicated on the Drawings.

D. Variations in smoothness of finished peastone surface shall be less than or equal to 1/4 in. when tested with a 10 ft. straightedge, applied both parallel to and at right angles to centerline of surface areas. Irregularities exceeding these requirements or that retain water on surface shall be corrected by removing defective work and replacing with new material conforming to this specification.

3.8 INSPECTION

A. Finished aggregate surfacing shall be smooth, uniform and solid. Cured and compacted aggregate shall be firm throughout profile with no spongy areas. Loose material shall not be present on the surface after installation but may appear after use and according to environmental conditions. Aggregate shall remain stable underneath loose decomposed granite on top. Surfacing shall appear “natural” yet stable throughout. Any significant irregularities in surfacing shall be repaired to the uniformity of the entire installation.

3.9 MAINTENANCE

A. Remove debris, such as paper, grass clippings, leaves or other organic material by mechanically blowing or hand raking the surface as needed. Any plowing program required during winter months shall involve the use of a rubber baffle on the plow blade or wheels on the plow that lifts the blade 1/4" off the paving surface.

3.10 REPAIRS TO STABILIZED STONE DUST

A. Excavate damaged area to the depth of the stabilized aggregate and square off sidewalls.

B. If area is dry, moisten damaged portion lightly.

C. Pre-blend the dry required quantity of stabilizer powder with the proper quantity of aggregate in a concrete batch mixer.

D. Add water to the pre-blended aggregate and stabilizer. Thoroughly moisten mix with 25 to 45 gallons per 1 ton of pre-blended material or to approximately 10% moisture content.

E. Apply moistened, pre-blended aggregate to excavated area to finish grade.

F. Compact with an 8 in. to 10 in. hand tamper or 250 lb. to 300 lb. roller. Keep traffic off areas for 12 to 48 hours after repair has been completed.

END OF SECTION

SECTION 321640

GRANITE CURB

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 granite curb as shown on the drawings and/or specified herein, including, but not necessarily limited to, the following:

1. Vertical granite curb.

1.3 RELATED SECTIONS

A. Cast-in-Place Concrete (Site) - Section 033055.

B. Site Excavating, Backfilling and Compacting - Section 312300.

C. Bituminous Paving - Section 321216.

1.4 QUALITY ASSURANCE

A. Unless otherwise indicated, granite curb materials and construction shall conform to the applicable portions of the New York State Department of Transportation standards, Sheet 609-01.

1.5 SUBMITTALS

A. Shop drawings of curb types and curb layout shall be submitted for Architect's approval. Drawings shall indicate joint locations.

B. Submit sample section of each type of curb, including regular, transition, end, inlet, corner, etc. for Architect’s approval.

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 GRANITE CURBS

A. Granite shall be a structural granite conforming to ASTM C 615, Class I Engineering Grade, suitable for curbstone use. Granite curb shall be similar to that produced by Williams Stone Company, East Otis MA, or approved equal.

1. Curb color shall be “Blue Sky”

2. Curb shall be free from seams which impair structural integrity, and with percentage of wear less than 32%, as determined by ASTM C 131.

3. Finish shall be sawn top and split sides.

B. All curb sections in radial layout shall be radiused sections. Straight tangent sections shall not be permitted in any curved layout of any dimension.

2.2 CEMENT MORTAR

A. Mortar for pointing joints between curbstones shall be a cement mortar composed of one part Portland cement and two parts sand, by volume with sufficient water to form a workable, stiff mixture.

2.3 CONCRETE

A. Concrete for foundation shall conform to Section 033055, "Cast-in-Place Concrete (Site)."

PART 3 EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions under which granite curbs 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 SETTING CURBS

A. Curbs shall be set in accordance with NYS DOT 609-01 standard for granite curbs.

B. Vertical face of vertical curb shall be plumb, with curb top parallel to adjacent surface.

C. Granite edging shall be installed in accordance with NYS DOT 609-01.

D. Curb shall be set accurately to line and grade. Curb units shall be fitted together as closely as possible. Curb shall not be field cut.

E. 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.

F. 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 321723
PAVEMENT MARKINGS

PART 1 – GENERAL

1.01 DESCRIPTION

A. This Section specifies requirements for removal of existing pavement markings and construction of new pavement markings.

B. The work includes:

1. Removal of existing markings by approved methods.
2. Pavement surface preparation.
3. Furnishing and installing new pavement markings.

1.02 RELATED SECTIONS

A. Sections which directly relate to the work of this Section include:

1. Section 310000 – EARTHWORK
2. Section 321100 – BASE COURSES (PAVEMENT)
3. Section 321216 – ASPHALT PAVING

1.03 SITE CONDITIONS

A. The Contractor shall cordon off areas where markings are being applied but maintain access for vehicular and pedestrian traffic as required for other construction activities. Flagmen, barricades, drums, warning signs, warning lights, and similar devices shall be used as required.

1.04 SUBMITTALS

A. Submit material certificate to the Engineer, signed by the material producer and Contractor, certifying that materials comply with these specifications and have been approved for use by New York State Department of Transportation Highway Division (NYSDOT).

PART 2 – PRODUCTS

2.01 MATERIALS

A. Traffic markings shall be yellow or white Traffic Marking Paint as manufactured by Sherwin-Williams (S-W) equal to Sherwin-Williams Paints ‘SetFast Acrylic Latex Traffic Marking Paint Yellow’ (S-W TM2161) or Sherwin-Williams Paints ‘SetFast Acrylic Latex Traffic Marking Paint White’ (S-W TM2160), or approved equal.

PART 3 – EXECUTION

3.01 PREPARATION

A. The Contractor shall clean the pavement of dust, dirt, old pavement markings, concrete curing compounds, and other foreign material which may be detrimental to the adhesion of the pavement marking materials.

3.02 PAVEMENT MARKING APPLICATION

A. The material shall be applied to the pavement by equipment designed and manufactured specifically for the application of pavement markings.

B. The Contractor shall employ the services of a registered land surveyor to provide control for layout of pavement markings.

C. Paint markings shall be applied at a minimum thickness of 15+ 1 mil. Thermoplastic markings shall be applied at 125 to 188 mils thickness.

D. Pavement markings shall be applied in accordance with the layout shown on the Drawings. No paint shall be applied to new bituminous pavement until the top course has cured at least one week, and allow two weeks curing for newly installed bituminous concrete curbing.

E. Where entire areas are to be cross-hatched, the striping shall conform to the cross-hatching shown on the Drawings.

F. All parking stall markings shall be straight with sharp corners and clean edges. Directional arrows, cross-hatching, lane divider stripes, stop lines, and lettering shall be painted white to the size, length, and spacing shown on the Drawings.

G. All markings shall be applied in one coat with brush, spray, or marking machine over clean dry pavement surfaces, when the atmospheric temperature is at or above 40°F., and when the weather is otherwise favorable in the opinion of the Engineer.

H. Use only skilled workmen who are experienced and normally employed in the work of installing pavement markings. Supply all the necessary equipment and materials required for the work.

I. The Contractor shall protect the buildings, walks, pavement, curbing, trees, shrubs, mulch, and other site fixtures from over-spray of paint and damage from pavement marking operations.

END OF SECTION 321723

SECTION 323113

CHAIN LINK FENCING AND GATES

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 furnishing and installing chain link fence and gate at boat storage area, as indicated on the Drawings and as specified herein.

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. Section 033000, CAST-IN-PLACE CONCRETE; Concrete.
2. Section 323129, WOOD, WIRE AND MESH FENCING AND GATES.

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):

A 120	Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses
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 385	High-Quality Zinc Coatings (Hot-Dip)
F 567	Installation of Chain-Link Fence

2. Chain Link Fence Manufacturers Institute (CLFMI):

Manual Product Manual

1.5 QUALITY ASSURANCE

A. Chain link fencing shall be manufactured In accordance with the requirements of the CLFMI Manual. Fence manufacturer shall be a CLFMI member.

B. Fence manufacturer shall have at least ten years of experience in the manufacture of galvanized steel chain link fencing.

1.6 SUBMITTALS

A. Submit sample of fence fabric for Architects review prior to installation.

B. Engineered shop drawings shall be submitted for all fence materials, including related hardware, for Architects review.

C. Submit manufacturer's certification that all fence materials conform to specification requirements.

PART 2 PRODUCTS

2.1 METALLIC COATED FENCE FABRIC

A. Fabric shall be a good commercial quality of steel wire of 2-1/2 in. mesh and 9 gage, galvanized wire with a minimum breaking strength of 1290 lb. in accordance with ASTM F 668.

B. Fabric shall be zinc-coated by the hot-dip process after fabrication in accordance with ASTM A 392. Weight of the zinc coating shall be not less than 2.0 oz. per sq. ft. Zinc used for coating shall conform to ASTM B 6.

2.2 FENCE POSTS, HARDWARE, AND FITTINGS - GENERAL

A. Fittings shall be of best quality malleable iron casting, wrought iron forgings, or pressed steel and provided with pin connections. Equipment shall be designed to carry 100% overload.

1. Malleable iron castings shall be hot-dipped galvanized in accordance with ASTM A 153.
2. Wrought iron forgings or pressed steel fitting and appurtenances shall be hot-dipped galvanized in accordance with ASTM A 123.
3. Fence hardware coatings shall match galvanized fence fabric coating.

B. Piping shall be steel conforming to ASTM A 120 except that pipe shall be unthreaded and untested for water pressure.

C. Galvanized items shall be galvanized in accordance with ASTM A 123, A 153, or A 385, as applicable.

D. Bolts which are installed 6 ft. or less above grade shall not protrude more than 1/4 in. beyond the nut after tightening. Rough edges shall be filed smooth to the satisfaction of the Architect. Peen ends of all bolts after tightening.

2.4 POSTS

A. Fence Posts:

1. Line post shall be 2.375 in. O.D., Schedule 40 galvanized steel pipe weighing 3.65 lb./ft.
2. End and corner posts shall be 2.875 in. O.D. Schedule 40 galvanized steel pipe weighing 5.79 lb./ft.
3. Gate posts shall be 4.0 in. O.D., Schedule 40 pipe weighing 9.10 lb./ft.

2.5 RAILS AND POST BRACES

A. Fence top rail, bottom rail, mid-rail, and post braces shall be 1.66 in. O.D. Schedule 40 galvanized steel pipe weighing 1.35 lb./ft.

2.6 STRETCHER BARS

A. Stretcher bars shall not be less than 3/16 in. x 3/4 in. and be full height of the fabric with which they are being used.

1. Provide stretcher bars for each end, corner, and pull post.

B. Stretcher bar bands and clips shall be heavy pressed steel, or malleable iron. At square post provide special design clips.

2.7 CAPS

A. Posts shall have caps which shall be designed to exclude water from post. Caps shall have holes suitable for the through passage of the top rail where necessary.

2.8 TENSION AND TIE WIRE

A. Tension wire shall be 7 gauge galvanized wire.

B. Tie wire shall be 9 gauge O.D. galvanized steel wire spaced 12 in. apart on rails and 12 in. apart on posts; ends shall be wound in a telegraph twist two and one-half turns.

2.9 GATES AND GATE FRAMES

A. Fabrication: Assemble gate frames by welding connections. Use same fabric as for fence, unless otherwise indicated. Install fabric with stretcher bars at edges, (and tie wire at top and bottom edges, if stretcher is not used). Attach stretcher bars to gate frame at not more

than 15 in. o.c. Attach hardware with rivets or by other means which will provide security against removal or breakage.

1. Framing:
   a. 6 ft. high, up to 8 ft. wide: Fabricate perimeter frames of minimum 1.660 in. O.D. Schedule 40 pipe weighing 2.27 lb./ft., or SS-40 pipe weighing 1.84 lb./ft., or 1.50 in. square steel tubing conforming to ASTM A 500, Grade B, hot-dip galvanized with a minimum 2.0 oz. zinc per sq. ft. of surface area.
   b. 6 ft. high, over 8 ft. wide: Fabricate perimeter frames of minimum 1.90 in. O.D. Schedule 40 pipe weighing 2.72 lb./ft., or SS-40 pipe weighing 2.28 lb./ft. or 2.00 in. square steel tubing conforming to ASTM A 500, Grade B, hot-dip galvanized with a minimum 2.0 oz. zinc per sq. ft. of surface area..
2. Bracing:
   a. Provide diagonal cross-bracing consisting of 3/8 in. diameter adjustable length truss rods on gates where four sided tension rods are not used. Provide frame rigidity without sag or twist.
3. Over 8 ft. ht. and 10 ft. wide provide additional horizontal and vertical members to ensure proper gate operation and for attachment of fabric, hardware and accessories.

B. Gate Hardware: Galvanize per ASTM A 153 (each gate)

1. Hinges: Pressed steel or malleable iron to suite gate size, non-lift-off type, offset to permit 180^{o} gate opening. Provide one pair of hinges for each leaf. (Up to 12 ft. ht.)
2. Latch: Forked type to permit operation from either side of gate: Provide padlock eye as integral part of latch.
3. Keeper: Provide keeper for gates, which automatically engages the gate leaf and holds it in the open position until manually released.
4. Double gates: Provide drop rod to hold inactive leaf. Provide pipe to engage the center drop rod. Provide locking device and padlock eyes as an integral part of the latch, requiring one padlock for locking both gate leaves.
5. Comply with ASTM F 654.

2.10 CONCRETE

A. Concrete shall be air-entrained type, conforming to Section 033000, CAST-IN-PLACE CONCRETE, except as modified below:

1. Minimum 28 day compressive strength shall be 2500 psi.
2. Maximum size of aggregate shall be 1-1/2 in.

PART 3 EXECUTION

3.1 INSTALLATION

A. Chain link fence installation shall conform to ASTM F 567, except as modified below.

B. Fence shall be of height and dimension as shown on Drawings, from finish grade to top rail.

C. Install fabric on security side of fence. Wire fabric shall be attached to frame, and tightly stretched such that it is flat, in uniform tension with no bulges or warping of fence after pulling force is released. Ties shall be spaced at 15 in. on horizontal rails and braces and 12 in. on posts. Bend ends of wire to minimize hazard to person or clothing. Top of fence shall approximately follow grade and shall have no abrupt changes in slope. Height of fence shall be constant.

1. Fasteners: Install nuts for tension band and hardware bolts on side of fence oppositefabric side.
2. Bolts: Used in the construction of fence shall be thoroughly peened.

D. Tension Wire: Provide tension line at bottom of fabric and at top (if top rail is not specified). Install tension wires before stretching fabric and tie to each post with ties or clips. Attach to fabric with hog rings 24 in. o.c.

E. Stretcher Bars: Extend through fabric and secure to end, comer, and pull posts with bandsor clips spaced not over 15 in. o.c.

3.2 FOUNDATIONS

A. Unless otherwise indicated on approved shop drawings, footing diameter shall be four times the largest cross section of the post. Post hole footing shall not be smaller than 10 in. diameter and 42 in. deep. Footing shall be bell-shaped.

B. Concrete shall be crowned at top to shed water.

C. Post hole footings shall be allow to cured 72 hours prior to any additional work.

3.3 POSTS

A. Layout:

1. End, corner and pull post: Provide at each termination and change in horizontal or vertical direction of 30 degrees or more.
2. Line Posts: Space uniformly at 10 ft. on center, unless otherwise indicated.

B. Concrete Set Posts: (Corner, End and Pull posts) Drill holes (after final grading) in firm, undisturbed or compacted soil. Holes shall have a diameter equal to four times the diameter of the post, and depths approximately 6 in. deeper than post bottom. Excavate deeper as required for adequate support in soft and loose soils, and for posts with heavy lateral loads.

1. Set post not less than 42 in. below surface when in firm, undisturbed soil.
2. Place concrete around posts in a continuous pour, tamp for consolidation. Trowel finish tops of footings, and slope or dome to direct water away from posts, except at walks.

C. Check each post for vertical and top alignment, and hold in position during placement and finishing operations.

3.4 BRACING AND FRAMING

A. Bracing: Install horizontal pipe brace at mid height, on each side of comer posts and at end and pull posts. Firmly attach with proper fittings. Install diagonal tension rods at these points. Install braces so posts are plumb when diagonal rod is under proper tension.

B. Top rail:

1. Random length, averaging not less than 18 ft.
2. Pressed steel sleeve joints, for rigid connections and expansion/contraction.

C. Center Rails: Only install center rails between posts spaced 12 ft. apart. Use with acceptable fittings and accessories.

3.5 GATES

A. Install gates plumb, level, and secure for full opening without interference.

B. Gate dimension is the center to center spacing of gate posts.

C. Gates shall work freely and shall have adequate clearance of the bottom. Adjust for smooth operation.

3.6 ADJUSTING

A. Gate: Adjust gate to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

3.7 TOUCH UP

A. Touch up damaged galvanized surfaces with galvanized paint.

END OF SECTION

SECTION 323129

WOOD, WIRE AND MESH FENCING AND GATES

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. Provide all equipment and materials, and do all work necessary to construct the wood, wire and mesh fence with wood posts, as indicated on the Drawings and as specified herein. Fencing types include:

1. Steel wire mesh fence and gate with cedar posts.
2. Steel wire mesh fence with timber posts and rails.
3. PVC coated steel wire mesh fence with cedar posts.

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. Section 033000, CAST-IN-PLACE CONCRETE; Concrete footings.
2. Section 323113, CHAIN LINK FENCING AND GATES; Galvanized steel chain link fence and gates.

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):

A 153	Zinc - Coating (Hot-Dip) on Iron and Steel Hardware
F 537	Design, Fabrication, and Installation of Fences Constructed of Wood and Related Materials

2. Federal Specifications (Fed. Spec.):

FF-T-276B	Thimbles, Rope

FF-C-450D (1) Clamps, Wire Rope

1.5 SUBMITTALS

A. Shop drawings of each fence type specified shall be submitted.

1. Show locations of fence, posts, braces, tension wires, details of hardware and accessories. Indicate materials, dimensions, sizes, weights, and finishes of components. Include plans, sections, details of mesh and post anchorage, attachment, bracing, and other required installation and operational clearances.
2. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

B. Submit duplicate samples of fence posts, braces, and mesh representing actual product with finished color and texture for Architect's approval.

C. 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.

D. Wood shall be Forest-Safe™, indicating that the supplier buys only from those mills who's forestry practices have been independently certified to conform with the most rigorous standards as set by the Forest Stewardship Council (FSC).

1. Furnish evidence indicating that source of wood used is a plantation farm or other designated source practicing sustain yield concept in forestry, and regulated by governing authorities regarding the growing, harvesting, and replanting of tropical hardwood trees.
   a. All lumber shall come stamped with the mills Forest Stewardship Council (FSC) chain-of-custody certification number, which allows it to be traced back to the originating well-managed forest.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer shall be capable of providing all cedar and metal fence materials specified in this section.

B. Installer Qualifications:

1. Installer shall have five (5) years experience installing fencing on the type and size of project specified by this section.
2. Installer shall be licensed, registered or otherwise approved by the local jurisdiction to install fencing.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Inspect the materials upon delivery to assure that specified products have been received. Store materials in safe area, away from construction traffic; store under cover and off ground, protected from moisture.

B. Keep materials clearly separated and identified with grade marks legible. Keep damaged material identified as damaged and stored separately.

1.8 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.9 SUPPLEMENTAL MATERIALS

A. Fasteners and supports shall conform to the requirements set forth by this section.

PART 2 - PRODUCTS

2.1 CEDAR LUMBER

A. Fence lumber shall be selected Northern White Cedar of sound stock, conforming to ASTM F 537, Architectural Class I Sawn Posts and Rails.

B. Fence Posts,k Rails, Gate Frames and Braces: Lumber shall be clear natural Northern White Cedar, ((Thujas Occidentalis), supplied S4S-E4E (surfaced four sides-eased four edges) of sound stock, new, straight, of consistent size, free of stains and mildew, and kiln dried to a moisture content of not more than 12%, by weight. Wood members shall be selected for best possible appearance from the grade of stock specified.

2. Northern White Cedar: Acceptable Manufacturer/Supplier: True North Cedar, Inc., P.O. Box 16065 Duluth, MN 55816; Ph: 360-201-1211; info@truenorthcedar.com; Liberty Cedar, 325 Liberty Lane, West Kingston, RI 02892; Tel. 1-800-882-3327; www.libertycedar.com, Kerber Farms and Mill Lumber Company, 3550 Coolidge Highway, Guilford, VT 05301; ph: 802-451-6920; fax: 802-257-7068; alt: 802-257-0614;kerbervt2000@yahoo.com, or other approved source.
2. Grade: Premium.
3. Color shall be “White Blonde”.

C. Lumber shall bear a mark of mill identification and shall bear the grade - trademark of the association under the rules or standards of which they were produced.

2.2 STEEL MESH MATERIALS

A. Steel Mesh: shall be Tornado Wire Titan 2096-12 or 2096-6, 12.5 ga. deer fence.

B. PVC Coated Wire Mesh: Trident Black PVC coated steel 1 in. hex fencing; thermally fused and bonded to a primer which is thermally cured onto galvanized steel core wire conforming to ASTM F 668.

C. Zinc for galvanized coating shall conform to ASTM B 6, galvanized by hot dipped method AISI Type I, before vinyl coating; coating shall be smooth. Minimum weight of zinc coating shall be 1.2 oz. per sq. ft.

D. PVC Coated Tension Wire: Trident Black PVC coated 8 ga. steel steel wire; thermally fused and bonded to a primer which is thermally cured onto galvanized steel core wire conforming to ASTM F 668.

E. Provide all anchors, bolts, sockets, sleeves, and other parts required for securing each item of work of this Section of the construction. Furnish required inserts and sleeves for installation in concrete under Section 033000, CAST-IN-PLACE CONCRETE.

F. Exposed fastenings shall be galvanized steel to match material and finish of the metal to which applied, or PVC coated black to match wire mesh, unless otherwise noted.

2.3 GATES AND GATE FRAMES

A. Fabrication: Assemble gate frames with mortise and tenon joints, sandwiching wire mesh between frame boards. Use same wire mesh as for fence, unless otherwise indicated.

B. Gate Hardware: Galvanize per ASTM A 153 (each gate)

1. Hinges: Stainless steel to suite gate size, non-lift-off type, offset to permit 180^{o} gate opening. Provide three hinges for each leaf.
2. Latch: Stainless steel as approved by Architect: Provide padlock eye as integral part of latch.

2.4 FASTENERS AND ACCESSORIES

A Tie Wires, Clips, and Fasteners: According to ASTM F 626.

1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, complying with the following:
   a. Hot-Dip Galvanized Steel: galvanized coating thickness matching coating thickness of steel mesh.

B. Nails: Provide one of the following:

1. Material: No. 304 stainless steel.
2. Material: Hot-dipped galvanized in accordance with ASTM A 153.

C. Screws: provide one of the following:

1. Material: No. 304 stainless steel.
2. Material: Double Hot-Dipped Galvanized in accordance with ASTM A 153.

D. Turnbuckles: Shall be galvanized and of the Eye and Eye type HG-226, or threaded eyebolt type, as required, manufactured by Crosby Group, Inc. Jacksonville, AR 72071 or approved equal. Size shall be 3/8 in, 6 in takeup with safe working load of 1,200 lbs. Ultimate loads must be at least five times safe working load. Turnbuckles shall meet requirements of Fed Spec FF-T-791b, Type 1, Form, 1, Class 8.

E. Wire clips shall be hot dipped galvanized, meeting Federal Specification FF-C-450, Type 1, Class 1. Cable thimbles shall be standard duty stainless steel and meet Fed Spec FF-T-276b, Type 2. Screw eye bolts shall be forged. Clips, thimbles and eyebolts shall be supplied by Crosby Group, Inc., sized as indicated on the Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance.

1. Do not begin installation before final grading is completed, unless otherwise permitted by Architect.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Stake locations of fence lines and terminal posts. Do not exceed intervals of 500 feet (152.5 m) or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

B. Coordinate work with related trades.

C. Discard wood members that are warped, twisted, bowed, crooked or otherwise defective.

3.3 FABRICATION AND WORKMANSHIP

A. Metal surfaces shall be clean and free from mill scale, flake, rust and rust pitting; well formed and finished to shape and size, true to details with straight, sharp lines and angles and smooth surfaces. Exposed sheared edges shall be eased.

B. Fasten all permanent connections as indicated on the Drawings.

C. Attach steel mesh to wood posts as indicated on the Drawings.

D. Fastenings shall be concealed where practicable. Thickness of metal and details of assembly and supports shall give ample strength and stiffness. Joints exposed to weather shall be formed to exclude water.

E. Do all cutting, punching, drilling, and tapping required for attachment of hardware and of work of other Sections where so indicated or where directions for same are given prior to, or with approval of, shop drawings.

3.4 SHOP COATINGS

A. Immediately before galvanizing, metal mesh materials shall have all rust, loose mill scale, dirt, weld flux, weld spatter, and other foreign material removed with wire brushes and/or steel scrapers. Power tool clean in accordance with SSPC SP 3. Remove grease and oil by use of recommended solvent.

B. Galvanizing: Components shall be hot-dip galvanized, including all bolts, nuts, washers, and other related ferrous metal items used therewith.

1. Hot-dip galvanizing process shall comply with ASTM A 123, A 153, A 385, and A 386 as applicable. After galvanizing, processed items shall be straightened to remove all warpage and distortion caused by the process.
2. Furnish certified statement that galvanizing complies fully with this Specification.

3.5 FENCE INSTALLATION

A. Materials shall be carefully handled and stored under cover in manner to prevent deformation and damage to the materials and to shop finishes. Prevent rusting and the accumulation of foreign matter on the metal work, and warping or staining of wood materials. All such work shall be repaired and cleaned prior to erection.

B. Work shall be erected square, plumb and true, accurately fitted, and with tight joints and intersections. All anchors, inserts and other members to be set into concrete shall be furnished loose by this trade to be built-into concrete by that trade as the work progresses. Later cutting or drilling shall be avoided wherever possible.

C. Install fwire mesh on security side of fence. Wire fabric shall be attached to frame, and tightly stretched such that it is flat, in uniform tension with no bulges or warping of fence or gate after pulling force is released. Unoless otherwise indicated on the Drawings, ties shall be spaced at 15 in. on horizontal rails and braces, and 12 in. on posts. Bend ends of wire to minimize hazard to person or clothing. Top of fence shall follow slope and alignment indicated on the Drawings . Height of fence shall be constant.

D. Wood and metal fence shall be rigidly braced and secured to surrounding construction, and shall be tight and free of rattle, vibration, or noticeable deflection after installation.

E. Electrolytic Isolation: Where dissimilar metals are to come into contact with one another, isolate by application of a heavy coating of bituminous paint on contact surfaces in addition to shop coat specified above. Do not permit the bituminous paint in any way to remain on surfaces to be exposed or to receive sealant.

3.6 FOUNDATIONS

A. Footing diameter shall be four times the largest cross section of the post. The depth shall be a minimum of 24 in. plus an additional 3 in. for each 1 ft. increase in fence height over 4 ft.

B. Post hole footing shall not be smaller than 12 in. in diameter and 36 in. deep.

C. Concrete shall be crowned at top to shed water.

D. Post hole footings shall be allow to cured 72 hours prior to any additional work.

E Where fencing is installed on concrete structures, use galvanized sleeve and grout posts.

3.7 POSTS

A. Concrete Set Posts: Drill holes (after final grading) in firm, undisturbed or compacted soil. Holes shall have a diameter equal to four times the diameter of the post, and depths approximately 6 in. deeper than post bottom. Excavate deeper as required for adequate support in soft and loose soils, and for posts with heavy lateral loads.

1. Set post not less than 35 in. below surface when in firm, undisturbed soil.
2. Place concrete around posts in a continuous pour, tamp for consolidation. Trowel finish tops of footings, and slope or dome to direct water away from posts.

3.8 ADJUSTING AND CLEANING

A. As work proceeds, maintain premises free of unnecessary accumulation of tools, equipment, surplus materials, and debris related to this work.

3.9 MAINTENANCE

A. Explain proper maintenance procedures to Owner or Owner's Representative at project closeout.

B. Visually inspect finish condition. Re-apply coating as necessary.

C. The use of pressure washers is not recommended.

END OF SECTION

SECTION 323900

BOLLARDS

1.1 SECTION INCLUDES

A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the manufactured metal bollards as shown on the drawings and specified herein.

1.2 RELATED SECTIONS

A. Cast-in-Place Concrete - Section 033000.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: All primary products specified in this section will be supplied by a single manufacturer with a minimum of ten (10) years' experience.

B. Installer Qualifications: All products listed in this section are to be installed by a single installer with a minimum of five (5) years' demonstrated experience in installing products of the same type and scope as specified.

C. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.

1. Finish areas designated by the Architect.

2. Do not proceed with remaining work until workmanship, color, and sheen are approved by the Architect.

3. Refinish mock-up area as required to produce acceptable work.

1.4 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.

B. Shop Drawings: Submit shop drawings depicting Manufacturer's approved construction details for all installation

C. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.

D. Verification Samples: For each finish product specified, two samples representing actual product, color, and patterns.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Upon receipt at the job site, all materials shall be checked to ensure that no damage occurred during shipping or handling. Materials shall be stored in such a manner to ensure proper ventilation and drainage, and to protect against damage, weather, vandalism, and theft.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Provide type 316 stainless steel bollards 36’high as manufactured by CalPipe or approved equal.

1. Shape: Round.

2. Finish: #4.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

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 in accordance with manufacturer's instructions as noted on the Contract Drawings.

3.4 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 329115

PLANTING SOIL

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 soil preparation as shown on the drawings and/or specified herein, including, but not necessarily limited to, the following:

1. Soil amendments.
2. Fertilizers and conditioners.
3. Topsoil.

1.3 RELATED SECTIONS

A. Rough grading - Section 312000.

B. Reinforced turf - Section 321443.

1.4 QUALITY ASSURANCE

A. Standards: Follow the specifications and recommendations of the American Association of Nurserymen (AAN) and applicable local agencies.

B. Laboratory Qualifications: Soil testing shall be conducted by Testing Agency approved by the Owner.

C. Required Analysis: Manufacturer's literature and laboratory tests are required to determine that the following soil quality and additives meet requirements of this Section for the following:

1. Organic amendments.
2. Commercial fertilizers.
3. Chemical additives.
4. Soil fertility recommendations in the form of application rates of individual chemical amendments for each soil tested.
5. Soil Mechanical Analysis: Soil particle size analysis (% sand, % silt, % clay).
6. Soil organic content.

1.5 SUBMITTALS

A. Samples: Submit, as required by laboratory, directly to laboratory. Identify each sample by soil mix type and intended plant material.

B. Soil Testing Analysis: Submit results of analysis.

C. Manufacturer's Certified Analysis: Submit with packaged standard products.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in manner to protect them from damage and contamination.

B. Store products in manner to protect them from damage and contamination, and to comply with manufacturer's storage instructions.

1.7 PROJECT CONDITIONS

A. Site Familiarization: Contractor is responsible for becoming familiar with site in relation to work of this Section and associated work in other parts of the Contract Documents.

B. Finish Grades: Contractor is responsible for bringing all areas to finished grades as indicated on Construction Drawings. Any variations or disturbances to the fine grading shall be corrected by the Contractor.

PART 2 PRODUCTS

2.1 ORGANIC MATTER

A. Sphagnum moss.

B. Leaf Mold: Thoroughly shredded, composted leaf material.

C. Local Product: As approved by the Landscape Architect.

2.2 CHEMICAL AMENDMENTS

A. Dolomite Lime: Agricultural grade mineral soil conditioner containing [**35**] percent minimum magnesium carbonate and [**49**] percent calcium carbonate, 100 percent passing #65 sieve.

B. Iron Sulfate (Ferric or Ferrous): [**30-35**] percent iron, [**35-50**] percent sulphur; supplied by commercial fertilizer supplier.

C. Sulphate of Potash: Agricultural grade containing [**50 percent to 53 percent**] of water-soluble potash.

D. Single Superphosphate: Commercial product containing [**18-20**] percent available phosphoric acid.

E. Calcium Nitrate: Agricultural grade containing [**15-1/2**] percent nitrogen.

F. Urea Formaldehyde: Commercial product containing [**38**] percent nitrogen.

2.3 MINERAL AMENDMENTS

A. Sand

1. Grading Dry Weight Basis:

Percent Passing	Sieve Designation
100	10 mm (3/8 inch)
95-100	2.00 mm (#10)
20-80	0.41 mm (#40)
0-5	0.075 mm (#200)

2. Chemical Properties:

   a. Salinity: Saturation extract conductivity shall not exceed 3.0 millimhos/cm.
   b. Boron: Concentration in saturation extract shall not exceed 1.0 parts per million.
   c. Sodium Absorption Ratio (SAR), as calculated from analysis of saturation extract, shall not exceed 6.0.

2.4 SOIL MIXES

A. General

1. Nutrient Analysis and Amendment: Unless specific amounts of chemical amendments are given in specification, the mix shall be tested for levels of pH, iron magnesium, potassium, phosphorous, salts, carbon, and nitrogen, and shall be adjusted to required fertility levels. The following are acceptable results for all soil types.

pH Range	5.0-7.0
Magnesium-Mg	100+ units
Phosphorous-P205	150+ units
Potassium-K20	120+ units
Carbon Nitrogen Ration-C/N	Max 30:1
Soluble Salts/Conductivity	Not to exceed 500 ppm/0.5 mmhos/cm (organics less than 5%), not to exceed 3000 ppm/2.5 mmhos/cm (organics greater than 5%)

2. Soil fractions shall be those defined by local Soil Conservation Service or similar entity. Soil fractions are by weight of mineral fraction without organics.

3. Organic content shall be tested by combustion test.

4. Unit weights shall be measured as wet density at 100 percent compaction and optimum moisture; reference ASTM D698.

5. Thoroughly combine all ingredients to create homogeneous mixtures prior to placement on subgrade.

B. Lawn Mix: On-site or imported material naturally occurring or amended to meet the following:

1. Loam, sandy loam, or clayey loam, reasonably free of subsoil, clay lumps, stones, or gravel of any dimensions, and debris. Free of excessive weeds, roots, and root mats, and any substance detrimental to plant growth. Imported topsoil shall be from an identifiable source.

2. Composition of Mineral Fraction:

   a. Sand: 20-60 percent.
   b. Silt: 12-50 percent.
   c. Clay: 7-40 percent.

3. Organic Content: 3-5 percent.

4. General requirements as defined for general soil mixes.

C. Shrub and Tree Mix Ratio: Approximately 3:1 by volume mixture of loam or sandy loam and organic amendment meeting the following requirements:

1. Composition of Mineral Fraction:

   a. Sand: 23-73 percent.
   b. Silt: 16-50 percent.
   c. Clay: 7-27 percent.

2. Organic Content: 4-8 percent.

3. General requirements as defined for general soil mixes.

D. Sand Based Structural Soil: Base Loam, Sand and Compost, each as specified above, shall be combined in an approximate mix ratio of four parts by volume Sand to one part by volume Base Loam to one and one-half parts by volume Compost (4S:1L:1.5C) to create a uniform blend which meets the following requirements.

1. Gradation for Material Passing the Number 10 Sieve:

	Percent Passing	
U.S. Sieve Size Number	Minimum	Maximum
10	100	-
18	68	90
35	38	63
60	18	39
140	9	18
270	7	10
0.002mm	1	2

2. Organic content: Between 2.0 and 3.0 percent by weight

3. The pH shall be between 6.0 and 6.5

4. Shall be CU-Structural Soil manufactured by Read Custom Soils, Wareham, MA

E. Reinforced Soil

1. Shall be Reinforced Soil manufactured by Read Custom Soils, Wareham, MA

2.5 MULCH

A. Standards: Mulch shall meet the highest standards set by the National Bark and Soil Producers Association. Mulch shall be well-aged, uniform in size, and free from foreign matter.

1. Surface mulch shall be well-aged fine shredded hardwood bark. It shall be dark brown in color, uniform in size, and free from foreign matter.

2. Pine needle mulch shall be top grade natural pine needles.

2.6 PREPLANT FERTILIZER

A. Components: 50 percent of nitrogen shall be derived from natural organic resources of urea-formaldehyde. Available phosphoric acid shall be from superphosphate, bone, or tankage. Potash shall be derived from muriate of potash containing 60 percent potash for each use. Fertilizer shall consist of the following percent by weight, or as determined by soil test, and shall be mixed by commercial fertilizer supplier:

1. Trees, Shrubs, Groundcovers, and Perennials:

a. 10 percent nitrogen.
b. 10 percent phosphorous.
c. 10 percent potash.

2. Lawn Areas:

a. 10 percent nitrogen.
b. 10 percent phosphorous.
c. 10 percent potash.

PART 3 EXECUTION

3.1 INSPECTIONS

A. Verify that subgrade compaction and grades, landscape walls, steps, planters, and other hardscape elements are in place, and have been accepted by the Landscape Architect.

B. Examine subgrade and rough grading before soil preparation. Alert Project Director/COR to unacceptable rough grading or subgrade.

3.2 SITE PREPARATION

A. General: Within the entire area to be landscaped, the Contractor shall complete the following site topsoil preparation items to eradicate existing weeds and natural groundcover. Initiate site topsoil preparation as stated herein, and coordinate work with irrigation system and utility lines.

B. Prepare areas to be landscaped by clearing weeds and groundcover, stumps, stones larger than 25 mm in diameter, roots, and debris or materials that may hinder proper grading, tillage, planting, or subsequent maintenance operations by approved means. Cleared material shall be totally removed from project site and properly disposed off of the property.

C. Subgrade Preparation: Subgrade of planting areas shall be loosened or scarified to a minimum of 75 mm (3 in.) depth prior to spreading planting soil. Subgrade shall be brought to true and uniform grade, and shall be cleared of stone greater than 50 mm (2 in.), sticks, and other deleterious and extraneous materials.

3.3 SOIL PLACEMENT

A. General

1. Place soil in locations and to depths shown on drawings or on schedules. Select placement and compaction methods that will not damage or dislodge drainage or irrigation systems.

2. Do no use muddy or frozen material.

3. Layering: If depth of planting soil exceeds 300 mm, place in multiple layers of 300 mm or less. Tamp each layer only enough to eliminate air pockets and to control settling. Do not over-compact; soil shall be free draining. Overfill deep placements to allow for settlement. Repair settled areas and uneven areas at end of guarantee period.

B. Lawns

1. Verify subgrade elevations, and correct discrepancies.

2. Apply chemical additives to soil at rate specified.

3. Mix soil amendments uniformly into soil by tilling, disking, or harrowing to 125 mm depth.

4. Rake topsoil to smooth, even surface, removing debris and stones exceeding 25 mm in any dimension.

3.4 MULCHING

A. Immediately install minimum 25 mm temporary mulch layer as erosion control. In areas where final mulch materials match requirements of this Section, the temporary layer may remain in place as part of the final mulch layer.

3.5 PRE-PLANTING FERTILIZATION

A. General: Apply preplant fertilizer at the following rates. Apply not more than seven days before planting. Work well into soil:

Trees	0.5 kg per 50 mm of trunk diameter, mixed throughout tree pit backfill
Shrubs	0.1 kg per 300 mm of height or spread; or 2.5 kg per 9 sq meters of bed for massed plantings
Groundcovers and Herbaceous Plants	0.5 kg per 3 sq meters of bed area
Lawns	450 kg per 4,000 sq meters (1 kg per 9 sq meters)

3.6 PROTECTION

A. General: Protect and avoid damage to existing utilities and to other site work in place.

B. Stabilization: Provide in manner to protect them from damage and contamination, and to comply with manufacturer's storage instructions.

3.7 PLACEMENT SCHEDULE

Location	Mix	Depth
Lawn Areas	Lawn Mix	200 mm
Shrub and Groundcover Beds	Shrub and Tree Mix	Per Drawing detail
Tree Pits	Shrub and Tree Mix	Per Drawing detail

END OF SECTION

SECTION 329119

LANDSCAPE GRADING

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 landscape grading as shown on the drawings and/or specified herein, including, but not necessarily limited to, the following:

1. Site grading.

1.3 RELATED SECTIONS

A. Planting Soil - Section 329115.

B. Plants and Planting - Section 329300.

1.4 QUALITY ASSURANCE

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):

a. ASTM D 1556 Density of Soil in Place by the Sand-Cone Method.
b. ASTM D 2167 Density and Unit Weight of Soil In Place by the Rubber-Balloon Method.

B. The Landscape Architect reserves the right to perform on-site observation during the grading operations. The observations may include, but not be limited to the following.

1. Observation of subgrade preparation for slab-on-grade and paved areas.

2. Observation of rough and finish grading operations.

C. Perform field density tests in accordance with Section 329115, "Planting Soil."

1. If, in the opinion of the Landscape Architect, based on reports of the testing service and inspection, the subgrade or fills which have been placed are below the specified density, additional compaction and testing will be required until satisfactory results are obtained.

D. The Landscape Architect's presence does not include supervision or direction of the actual work by the Contractor, his employees, or agents. Neither the presence of the Landscape Architect, nor any observations and testing performed by him shall excuse the Contractor from defects discovered in his work.

1.5 SUBMITTALS

A. Samples: Submit, as required by laboratory, directly to laboratory. Identify each sample by soil mix type and intended plant material.

B. Soil Testing Analysis: Submit results of analysis.

C. Manufacturer's Certified Analysis: Submit with packaged standard products.

1.6 PROJECT CONDITIONS

A. Site Familiarization: Contractor is responsible for becoming familiar with site in relation to work of this Section and associated work in other parts of the Contract Documents.

B. Finish Grades: Contractor is responsible for bringing all areas to finished grades as indicated on Construction Drawings. Any variations or disturbances to the fine grading shall be corrected by the Contractor.

PART 2 PRODUCTS

2.1 SOURCE OF MATERIALS

A. Material shall be obtained from required on-site excavation, to the extent that suitable material is available, and from off-site sources, to the extent that suitable material is not available from on-site excavation. Refer to Section 329115, "Planting Soil."

PART 3 EXECUTION

3.1 EXISTING CONDITIONS

A. By submitting a bid, the Contractor affirms that he has carefully examined the site and all conditions affecting work under this Section. No claim for additional costs will be allowed because of lack of full knowledge of existing conditions.

3.2 PROTECTION OF EXISTING STRUCTURES AND UTILITIES

A. The work shall be executed in such manner as to prevent any damage to adjacent property and any other property and existing improvements such as, but not limited to, streets, curbs, paving, utility lines and structures, monuments, benchmarks and other public and private property.

B. In case of any damage or injury caused in the performance of the grading work, the Contractor shall, at his own expense, make good such damage or injury to the satisfaction of, and without cost to the Owner. Existing roads, sidewalks, and curbs damaged during the grading work shall be repaired or replaced to their original condition at the completion of operations. The Contractor shall replace, at his own cost, existing benchmarks, monuments, and other reference points which are disturbed or destroyed.

3.3 COORDINATION

A. Prior to start of grading operations, the Contractor shall arrange an on-site meeting with the Landscape Architect for the purpose of establishing Contractor's schedule of operations and scheduling inspection procedures and requirements.

B. As construction proceeds, the Contractor shall be responsible for notifying the Landscape Architect prior to start of grading operations requiring inspection and/or testing.

C. The Contractor shall be responsible for obtaining test samples of soil materials proposed to be used and transporting them to the site sufficiently in advance of time planned for use of these materials for testing of materials to be completed. Use of these proposed materials by the Contractor prior to testing and approval or rejection, shall be at the Contractor's risk.

3.4 GRADING

A. Uniformly grade areas within the limits of site grading under this section, including adjacent transition areas. Smooth finished surfaces within specified tolerances, and between points where elevations are shown, or between such points and existing grades.

B. The degree of finish required will be that ordinarily obtainable from either blade-grader or scraper operations.

1. Ditches: Finish ditches to ensure proper flow and drainage. Conduct final rolling operations to produce a hard, uniform, and smooth cross-section.

2. Finish Grading - Lawn or Unpaved Areas: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch (13 mm) of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.

3. Grade Breaks located on the plans indicate crisp transitions, not blended or rounded edges. These should be clean, sharp, and uniform in line and curve as indicated on the plans.

4. Walks: Shape the surface of areas under walks to line, grade and cross-section, with the finish surface not more than 0.00 ft. above or 0.10 ft. below the required subgrade elevation, compacted as specified, and graded to prevent ponding of water after rains.

5. Pavements: Shape the surface of the areas under pavement to line, grade and cross-section, with the finish surface not more than 1/2 in. above or below the required subgrade elevation, compacted as specified, and graded to prevent ponding of water after rains. Include such operations as plowing, discing, and any moisture or aerating required to provide the optimum moisture content for compaction. Fill low areas resulting from removal of unsatisfactory soil materials, obstructions, and other deleterious materials, using satisfactory soil material. Shape to line, grade, and cross-section as shown on the Drawings.

3.5 MAINTENANCE

A. Protect newly graded areas from traffic and erosion. Keep free of trash and debris.

B. Repair and re-establish grades in settled, eroded, and rutted areas to the specified tolerances.

C. Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify the surface, re-shape, and compact to the required density prior to further construction.

END OF SECTION

SECTION 329200

LAWNS AND GRASSES

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. Provide all materials and equipment, and do all work required to complete the seeding and sodding to establish lawn areas, and seeding and plugging of native meadow areas, 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. Section 312300, SITE EXCAVATING, BACKFILLING AND COMPACTING; Excavation and backfill.
2. Section 329115, PLANTING SOIL.
3. Section 329119, LANDSCAPE GRADING.
4. Section 329300, PLANTING; New plantings.

1.4 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 136	Sieve Analysis of Fine and Coarse Aggregates
D 422	Particle-Size Analysis of Soils
E 11	Wire-Cloth Sieves for Testing Purposes

1.5 SUBMITTALS

A. Samples: The following samples shall be submitted:

Material	Quantity (lb.)
Seed, each mix	1

B. Manufacturer's Product Data: Manufacturer's product data shall be submitted for the following materials:

Cellulose fiber mulch
Soil stabilization fibers

C. Certificates: Labels from the manufacturer's container certifying that the product meets the specified requirements shall be submitted for the following materials:

Grass seed
Meadow seed

1.6 DELIVERY, STORAGE, AND HANDLING

A. Digging Sod/plugs:

1. Sod/plugs shall not be dug at the nursery or approved source until ready to transport sod/plugs to the site of the work or acceptable storage location.
2. Before stripping, sod/plugs shall be mowed at a uniform height of 2 in.
3. Cut sod/plugs to specified thickness and to standard width and length desired.

B. Transportation of Sod/plugs:

1. Sod/plugs 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/plugs.
2. Evidence of inadequate protection following the digging, carelessness while in transit, or improper handling shall be cause for rejection.
3. Sod/plugs shall be kept moist, fresh, and protected at all times. Such protection shall encompass the entire period during which the sod/plugs is in transit, being handled, or are in temporary storage.
4. Upon arrival at the temporary storage location or the site of the work, sod/plugs material shall be inspected for proper shipping procedures. Should the sod/plugs be dried out, the Architect will reject the sod/plugs. When sod/plugs 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 Architect, the Contractor shall notify the Architect at least two working days in advance of the anticipated delivery date of sod/plugs material. Certificate of Inspection when required shall accompany each shipment.

C. Handling and Storage of Sod/plugs:

1. Sod/plugs material shall be handled with extreme care to avoid breaking or tearing strips.
2. Sod/plugs shall not be stored for longer than 30 hours prior to installation. Sod/plugs shall be stored in a compact group and shall be kept moist. Sod/plugs shall be prevented from freezing.
3. Sod/plugs that has been damaged by poor handling or improper storage will be rejected by the Architect.

D. Deliver seed in original sealed containers, labeled with analysis of seed mixture, percentage of pure seed, year of production, net weight, date of packaging, location of packaging, and name of seed grower. Damaged packages will not be accepted.

E. Seed shall be stored under cool and dry conditions so that the endophytic seed in the mixture is capable of maintaining a high level of endophytes

1.7 PLANTING SEASON

A. Planting season shall be as follows:

Material	Planting Season	
	Spring	Fall
Sodding	3/15 to 5/15	8/15 to 10/15
Seeding (Lawn)	3/15 to 5/15	8/15 to 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 Architect.

1.8 ACCEPTANCE

A. Acceptance:

1. The Architect will inspect all work for Substantial Completion upon written request of the Contractor. The request shall be received at least ten calendar days before the anticipated date of inspection.
2. Acceptance of material by the Architect will be for general conformance to specified requirements, and shall not relieve the Contractor of responsibility for full conformance to the Contract Documents.
3. Upon completion and reinspection of all repairs or renewals necessary in the judgement of the Architect, the Architect will recommend to the Owner that the work of this Section be accepted.

B. Sod and seed areas will be accepted when in compliance with all the following conditions:

1. Roots are thoroughly knit to the soil;
2. Absence of visible joints (sodded areas);
3. All areas show a uniform stand of specified grass in healthy condition;
4. At least 60 days have elapsed since the completion of work under this Section.

C. Plugs areas will be accepted when in compliance with all the following conditions:

1. Roots are thoroughly knit to the soil;
2. All areas show a uniform stand of specified grass in healthy condition;
3. At least 60 days have elapsed since the completion of work under this Section.

D. Native Seed Acceptance

1. The Contractor shall guarantee seeded areas will meet or exceed the following performance criteria one full year after Provisional Acceptance.
   a. Within three months of seeding, total vegetation cover in all zones shall exceed 50% (by areal cover).
   b. Total vegetation cover in all zones combined shall exceed 75% (by areal cover), and 5% of all species present shall be native.
      Seedlings from 10% of seeded grass species shall be present in all zones combined.
   c. Seedlings from 20% of seeded forb species shall be present in all zones combined.
   d. The Contractor shall guarantee seeded areas will meet or exceed the following performance criteria two full years after Provisional Acceptance.
   e. Total vegetation cover in all zones combined shall exceed 70% (by areal cover).

1.9 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful establishment of plants.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. Experience: Five years' experience in landscape installation in addition to requirements in Division 01 General Requirements.
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress

B. Seeding and Meadow Seeding Work: Contractor shall have a minimum of five years experience in work of the type required by this Section.

C. All native seed species shall be supplied as pure live seed.

D. All native seed mixes to be applied at the rates and quantities of seeds per acre specified on the Plans.

PART 2 PRODUCTS

2.1 LAWN SEED

A. Seed mixture: Standard grade seed of the most recent season's crop. Seed shall be dry and free of mold. Where possible, seed shall be inoculated with endophytes. Seed mixture shall be as follows:

1. Loft’s Premium Gold Tag Seed:

   a. Shade Mix: Special mixture
   25% Jamestown II Chewing Fescue
   20% Cascade Chewings Fescue
   20% Cindy Creeping Red Fescue
   20% Creeping Red Fescue
   15% Laser Poa Trivialis

   b. Sun Mix: 70 Blue / 30 Rye Mixture
   24% Certified Baron Kentucky Bluegrass
   23% Certified Georgetown Kentucky Bluegrass
   23% Certified Ram I Kentucky Bluegrass
   15% Certified Yorktown III Perennial Ryegrass

15% Certified Repell II Perennial Ryegrass

2.2 LAWN SOD

A. Certified Turfgrass Sod: 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.

1. Sod shall be Black Beauty Improved Tall Fescue, or approved equal.

B. 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.

C. Thickness of Cut: Sod shall be machine cut at a uniform soil thickness of 5/8 in., plus or minus 1/4 in., at the time of cutting. Measurement for thickness shall exclude top growth and thatch.

D. 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 in. on width, and plus or minus 5% on length. Broken strips and torn and uneven ends will not be acceptable.

E. 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.

F. Moisture Content: Sod shall not be harvested or transplanted when moisture content (excessively dry or wet) may adversely affect its survival.

G. 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 Architect prior to its installation.

H. Thatch: Sod shall be relatively free of thatch. A maximum of 1/2 in. (uncompressed) thatch will be permitted.

I. 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.

J. Weeds: Sod shall be free of objectionable grassy and broad leaf weeds. Turfgrass sod shall be considered free of such weeds if less than five such plants are found per 100 sq. ft. of area.

1. Turfgrass sod shall not be acceptable if it contains any of the following weeds: common bermudagrass (wiregrass), quackgrass, johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel and bromegrass.

2.3 MEADOW SEED SOURCES

A. Seed mixture: As indicated on the Drawings. Seed sources shall be one of the following or other Architect approved source:

Ernst Conservation Seeds, Inc.

8884 Mercer Pike
Meadville PA 16335
(800) 873
http://www.ernstseed.com/seed-mixes

NESeed
122 Park Ave, Building H
East Hartford, CT 06108
(800) 825 4577
https://www.neseed.com/

New England Wetland Plants, Inc.
820 West Street
Amherst, MA 01002
(413)548 8000
http://newp.com/

2.4 MEADOW PLUGS

A. Certified Native Perennial Plugs and Small Containers: Superior plugs 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. Native perennial plugs and small containers plugs shall meet the published state standards for certification.

1. Meadow Areas: Plugs shall be a mixture of native meadow plants and grasses, as indicated on the Plant Schedule (on the Drawings)

B. Plugs shall be nursery grown on cultivated mineral agricultural soils. Plugs shall have been mowed regularly and carefully, and otherwise maintained from planting to harvest.

C. Moisture Content: Plugs shall not be harvested or transplanted when moisture content (excessively dry or wet) may adversely affect its survival.

D. Time Limitations: Plugs shall be harvested, delivered, and transplanted within a 36 hour period unless a suitable preservation method is approved prior to delivery. Plugs not transplanted within this period shall be inspected and approved by the Architect prior to its installation.

E. Thatch: Plugs shall be relatively free of thatch. A maximum of 1/2 in. (uncompressed) thatch will be permitted.

F. Diseases, Nematodes, and Insects: Plugs shall be free of diseases, nematodes, and soil-borne insects. State Nursery and Plant Materials Laws require that all plugs be inspected and approved for sale. The inspection and approval must be made by the State Agricultural Department, Office of the State Entomologist.

G. Weeds: Plugs shall be free of objectionable grassy and broad leaf weeds. Native perennial plugs and small containers plugs shall be considered free of such weeds if less than five such plants are found per 100 sq. ft. of area.

1. Native perennial plugs and small containers plugs shall not be acceptable if it contains any of the following weeds: common bermudagrass (wiregrass), quackgrass, johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, bromegrass, cogon grass, bluestem, topedo grass, penny wort and live Chinese tallow.

2.5 SOD FARM GROWING MEDIUM

A. Sod farm growing medium shall be as specified in Section 329115, PLANTING SOIL.

2.6 PLANTING SOILS

A. Fiber reinforced soil mix and other turf soil mixes shall be as specified in Section 329115, PLANTING SOIL.

2.7 WATER

A. Water shall be suitable for irrigation and free from ingredients harmful to seeded or sodded areas.

2.8 SOIL AMENDMENTS

A. Soil amendments shall be as specified in Section 329115, PLANTING SOIL.

2.9 CELLULOSE FIBER MULCH

A. Cellulose fiber mulch shall be composed of virgin wood, contain a green color additive, be weed free, and non-polluting, containing no germination or growth - inhibiting factors, similar to Hydro Mulch, manufactured by Conwed Corporation, St. Paul, Minnesota 55113.

2.10 WEED CONTROL

A. Weed control for stockpiled topsoil shall be a non-selective weed killer for control of grassy and broadleaf weeds; weed control shall have short residual, allowing seeding and sodding operations to occur within 7 days of application.

PART 3 EXECUTION

3.1 PREPARATION OF SUBGRADE

A. Subgrade shall be examined to ensure that rough grading and all other subsurface work in lawn areas and other areas to be seeded or sodded is done prior to start of seeding.

B. Existing subgrade shall be loosened or scarified to a minimum depth of 3 in. prior to spreading topsoil. Subgrade shall be brought to true and uniform grade, and shall be cleared of stones greater than 3 in., sticks, and other extraneous material.

3.2 EXAMINATION

A. For native seeding:

1. Examine areas to receive native seeding for compliance with requirements outlined above. Check that finish grades slope to drain, are free of depressions or other irregularities after thorough settlement and compaction of soil, and are uniform in slope between grading controls and the elevations indicated in the Plans. If finish grades are determined by the Architect to be insufficient for seeding, the Contractor shall re-grade areas as directed by the Architect.
2. Ensure ground layer is cleared of leaf litter and other duff prior to seeding. Submit to the Architect for approval the method for making seed contact with the soil where the soil will not be graded or otherwise disturbed prior to seeding.

3. Proceed with installation only after unsatisfactory conditions have been corrected. Obtain approval from Architect regarding pre-installation conditions before proceeding.

3.3 PLACING AND SPREADING PLANTING SOIL

A. Planting soil shall not be spread until it is possible to follow immediately or within 24 hours with seeding and sodding operations. If planting soil is spread prior to this time it shall be cultivated to loosen soil prior to seeding and sodding.

B. Placing and spreading planting soil shall be performed as specified in Section 329115, PLANTING SOIL.

C. Restore prepared areas if eroded or otherwise disturbed after fine grading and before planting.

3.4 APPLICATION OF SOIL AMENDMENTS

A. Fertilizer and conditioners shall be applied as specified in Section 329115, PLANTING SOIL.

3.5 FINISH GRADING

A. Contractor shall set grade lines for Architect's review and approval.

1. Final surface of topsoil immediately before seeding and sodding shall be within + 1/2 in. of required elevation, with no ruts, mounds, ridges, or other faults, and no pockets or low spots in which water can collect. Stones, roots, and other debris greater than 1 in. in any dimension, which are visible at the surface, shall be removed and the resulting holes filled with topsoil, leaving a uniform planar surface.

B. Finish grade surface with a drag or rake. Round out all breaks in grade, smooth down all lumps and ridges, fill in all holes and crevices. Rolling with a light roller is acceptable, if the surface is scarified afterward.

1. Lawn: Compaction of topsoil for finish grade shall be in accordance with Section 329115, PLANTING SOIL.

C. In the event of settlement, the Contractor shall readjust the work to required finished grade.

3.6 LAWN SEED APPLICATION

A. Seed shall be applied inn two applications; first shall be by mechanical spreader; second shall be by hydroseeding method as specified below.

B. First Application: Seed shall be broadcast by means of an approved mechanical spreader, to give a uniform application at the following rates:

Seed	Application Rate lb./1,000 s.f.
Seed Mixture	as per supplier's printed recommendations

1. Seed shall be applied in two equal applications for uniform coverage; direction of travel of spreader for second pass shall be perpendicular to that of the first pass. Seeding shall not be done when it is raining or snowing, or when wind velocity exceeds 5 mph.
2. Following seeding the area shall be lightly raked to mingle seed with top 1/8 to 1/4 in. of soil. Area shall then be fine graded. Stones and other debris greater than 1 in. in any dimension which are visible on surface shall be removed.

C. Following seeding and raking, entire area shall be rolled with a hand roller having a weight of 60 to 90 lb./ft. of width, and a minimum diameter of 2 ft. Entire area shall then be watered by use of lawn sprinklers, or other approved means. Initial watering shall continue until the equivalent of a 2 in. depth of water has been applied to entire seeded surface, at a rate which will not dislodge the seed. Watering shall be repeated thereafter as frequently as required to prevent drying of the surface, until the grass attains an average height of 1/4 in. Watering methods and apparatus which may cause erosion of the surface shall not be permitted.

D. At Contractor's Option: In lieu of mechanical spreader, seed may be spread by the hydroseeding method, utilizing power equipment commonly used for that purpose.

1. Seed, lime, fertilizer, and mulch shall be mixed and applied to achieve application quantities specified herein for the conventional seeding method, with mulch applied at the rate of 1,200 lb./acre. Other provisions specified above for conventional seeding shall apply also to hydroseeding.
2. Mulch shall be applied in two stages with 5% to 10% of the quantity applied with seed and the balance applied separately.
3 Seed shall not be placed in water until immediately before application.
4. Centrifugal pumps shall not be used to apply seed mix without fiber mulch. Hand broadcast or use gear pump.
5. Gelscape shall be incorporated at the rate of 15 lb. per acre.

E. Rope off entire seeded area to prevent vehicles and pedestrians from entering area.

3.7 SODDING

A. 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.

B. Sod shall be placed and all sodding operations completed within 72 hours following stripping from sod source bed.

C. On slopes steeper than 2 to 1, sod shall be fastened in place with suitable wood pins or other approved methods, spaced at not less than 1 pin per square foot.

D. 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 or overlapped. Immediately after laying sod shall be pressed firmly into contact with sod bed by tamping or rolling, to eliminate air pockets. Following compaction, topsoil shall be used to fill all cracks, and excess soil shall be worked into grass with rakes or other suitable equipment. Sod shall not be smothered with excess fill soil.

E. 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.

F. Completed sod shall immediately be watered sufficiently to uniformly wet the soil to at least 1 in. below the bottom of sod bed.

3.8 MAINTENANCE OF SEEDED AND SODDED LAWNS

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 areas shall begin upon completion of seeding and shall continue until acceptance of the building, or until mowing as specified below is completed, or until average height of grass is 1-1/2 in., whichever occurs later.

1. Watering
   a. Week No. 1: Provide all watering necessary to keep seed bed moist at all times. Perform watering daily or as necessary to maintain moist soil to a depth of 4 in.
   b. Week No. 2 and until acceptance of the building, or until mowing as specified below is completed, or until average height of grass is 1-1/2 in., whichever occurs later: Water as necessary to maintain adequate moisture in the upper 4 in. of soil to promote seed germination.
2. Mowing
   a. Not more than 40% of the grass leaf shall be removed during the first or subsequent mowings.
   b. Bluegrass and other cool season grasses shall be maintained between 1-1/2 in. and 2-1/2 in.
   c. All clippings shall be removed.

C. Maintenance of sodded areas shall begin upon completion of 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.

1. Watering
   a. Week No. 1: Provide all watering necessary for rooting of sod. Soil on sod pads shall be kept moist at all times. Perform watering daily or as necessary to maintain moist soil to a depth of 4 in. Watering shall be done during the heat of the day to prevent wilting.
   b. Week No. 2 and Subsequent Weeks: Water as necessary to maintain adequate moisture in the upper 4 in. of soil to promote deep root growth.
2. Mowing
   a. Mowing shall not be attempted until the sod is firmly rooted and securely in place. Not more than 40% of the grass leaf shall be removed during the first or subsequent mowings.
   b. Bluegrass and other cool season grasses shall be maintained between 1-1/2 in. and 2-1/2 in.
   c. All clippings shall be removed.
   d. After 2 mowings, the Contractor shall top dress the sod with an application of fertilizer at the rate of 1 pound of actual nitrogen per 1000 square feet.

D. After grass has sprouted, seeded areas which fail to show a uniform stand of grass shall be replanted as often as necessary to establish an acceptable stand of grass.

1. Scattered bare spots, shall not exceed 15 sq. in. each.

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.

F. If lawn or grass is established in the fall and maintenance is required to continue into spring months, lawn and grass shall receive an application of lime and fertilizer in the spring. Lime and fertilizer shall be spread in a uniform layer over the entire lawn surface, at the following rates.

Material Application Rate

Lime	100 lb./1000 sq. ft.
Fertilizer	20 lb./1000 sq. ft.

G Remove rope barricades only after second cutting of lawns.

3.9 MEADOWS - SITE PREPARATION

A. Two interrelated and variable actions are needed prior to meadow seeding:

1. Establishment of a temporary cover crop to stabilize the soil and prevent erosion until the correct time for meadow seeding and
2. Weed control.

NOTE: These recommendations may need to be modified depending on the time of season/ weather conditions when the final grading is completed and on the abundance and types of weeds present in the soil – this simply cant be determined before the actual soil is in place, after final grading. On-site consultations to observe agronomic conditions during the planting and establishment periods are strongly recommended.

Because site grading will involve spreading of stockpiled existing/amended soil, most likely there will be a large number of weed seeds present that will germinate rapidly (because some will end up in the perfect soil habitat to germinate) at any time during the growing season.

If these weeds are not controlled, they may out-compete the meadow seedlings, and because these annuals mature rapidly, they will produce a new crop of annual weed seeds, continuing the weed problem into the following year - and preventing the meadow from successful establishment. Failure to control weeds is the most common cause of meadow failure.

B. After final grading, seed all areas with Annual Ryegrass (Lolium multiflorum) (not winter or cereal rye) at 8 pounds per 1000sf. Areas with steep slopes can be mulched lightly with 1-2” of straw (not hay!) to prevent erosion. Annual Rye will prevent erosion and help to control weeds. The annual rye cover will establish quickly during the spring or fall growing season. The Annual Rye will die off the following season without reseeding. The perfect nurse /cover crop.

C. Inspect the Annual Ryegrass after establishment (30-45 days) to assess the amount of weeds present (growing with the rye grass) see 1 or 2 below:

1. Minimal Weeds Present. If the weeds in the Annual Rye are minimal/few, mow repeatedly at a height of 4-6” to prevent weeds from maturing and setting seed (most are annuals). Continue mowing regularly at 4-6” until late fall then seed the meadow through the Annual Rye using a slit seeder (see meadow seeding).
2. Significant Weeds Present: If the weeds are significant or dominant within the Annual Rye, herbicide treatment is necessary (agronomic inspection recommended). When the weeds are growing vigorously (May – October) spray with Glyphosphate (Roundup), which is a non-selective foliar herbicide. The Round-up will kill the weeds and the Annual Rye. The dead plants should provide adequate erosion protection – if necessary a small amount of straw can be added(perhaps on the steeper berm slopes). Inspect weekly and spot-treat/spray any surviving, or new weeds again with Glyphosphate until the appropriate planting time. Do not disturb the soil any more than necessary during herbicide treatment, as this will expose new weeds seeds to favorable conditions for germination (better to hand spray than to drive a tractor over it). Just before meadow seeding, mow the dead weeds and rake the debris, again try not to disturb the soil, as this will expose new weed seeds to germination.

3.10 MEADOW SEED APPLICATION

A. Prepare planting sites as discussed above. Be sure to wait a minimum of 2 weeks after the last Glyphosphate treatment before seeding, and cut using a flail mower and rake and remove the dead plants. Remove debris from the planting locations. If seeding into Annual Rye, mow short before seeding.

B. Timing: Seeding should be done when soil is near normal moisture conditions (moist, not saturated, no puddles). If the soil is too wet, wait until it dries. Germination is not desired in the fall, so irrigation shall not be necessary. Seeding should not be done under windy conditions, as the grass seeds are light and fluffy and may blow away.

C. Acceptable planting times/seasons include:

1. Fall/Dormant Seeding (Preferred)
   a. For best results, native meadow seeding should occur in late fall – October to early November - and can take place into the dormant season until the ground is frozen or snow covered. Many of the seeds require cold scarification for germination. If fall seeding is occurs too early in the season, seeds which do not require cold scarification (approximately 10% of most mixes) may germinate before becoming hardened off and may die from the frost.
2. Spring and Early Summer Seeding
   a. Seeding in the spring and early summer is acceptable. While earlier planting is preferred (after the risk of frost), late spring and early summer seeding will require a light layer of weed free straw mulch to conserve soil moisture. If conditions are drier than usual watering may be required (See section 3.7).

D. Seeding shall occur no sooner than 24 hours after herbicide application and no greater than 14 days after herbicide application.

E. Sowing rates vary with mix of species but are usually much lighter than turfgrass seed application rates.

F. Seeding Methods: Seed mixes shall be applied using one of the following acceptable methods:

1. Drill Seeding
   a. If using a seed drill or slice/slit seeder and the seeds do not come premixed, the grass and forb seeds should be mixed, weighed, and applied separately. The forb seed is much smaller than the grass seed in quantity and should therefore be very carefully weighed and separated according to the mix rates. Note: if an accurate scale is not available, the seed quantities can be divided in proportion to the total amount of seed to be used for each area. Mix the forb mix with two to four times the volume of damp sand, sawdust, or horticultural vermiculite as an inert “filler” material.
   b. The slicing seeder should be calibrated to provide the recommended seeding rates. For the grass and forb seed, seed in two perpendicular passes. This assumes that the seeding machine is calibrated for 50% of the recommended seeding rate. Applying the seed in multiple passes will break up the ryegrass more completely, and will help to assure a more uniform distribution of seed throughout the meadow, and will help to assure good soil:seed contact.
2. Broadcasting
   a. Broadcast seeding can be accomplished by hand or using a hand operated mechanical spreader. If seeds do not come premixed from the supplier, grass and forb seed should be mixed together with two to four times the volume of damp sand, sawdust, or horticultural vermiculite as an inert “filler” material. Seed shall be applied in two perpendicular passes at 50% of the recommended seeding rate. Applying the seed in multiple passes will help to assure a more uniform distribution of seed throughout the meadow. Lightly rake or roll with a cultipacker after seeding.

G. Do not use wet seed or seed that is moldy or otherwise damaged.

H. Seeding operations must occur when soil moisture is appropriate and areas are in a friable condition and neither hard nor muddy

I. Lightly roll seeded areas with a cultipack roller and water with fine spray.

J. Ensure seeds have proper stratification and/or scarification to break seed dormancy for spring emergence.

3.11 MEADOWS - RAKE, ROLL, MULCH

A. The Meadow should be lightly raked or rolled with a cultipacker after seeding to ensure good soil:seed contact. After the seed mixes have been applied to all areas, rake or roll the seeded areas so they are lightly covered with soil, 1/4 – 1/2" deep.

3.12 MEADOW ESTABLISHMENT

A. Irrigation During Germination (Spring-Summer Planting Only)

1. For optimal germination it is recommended that seeded areas receive a minimum of 0.25 inch of natural rainfall or irrigation within 10 days of seeding. If natural rainfall is not received within 10 days, it shall be the responsibility of the Contractor to irrigate the new seeding with a minimum of 0.25 inch of water, or so that the water penetrates the soil to a uniform minimum depth of 4.0 inches.
2. The soil of the seedbed should be maintained in a moist condition for 6-8 weeks after seeding – as necessary to favor germination and the critical early establishment period, depending on precipitation.
3. For fall seeding the meadows are not expected germinate so they do not require irrigation.

3.13 MEADOW MANAGEMENT

A. First Growing Season

1. Mowing the meadow is an important management practice during the first growing year. Mowing favors perennial meadow species over annual weeds that may be present. The first mowing should start when the tallest growth approaches 12" (mid – late June). Mow at a height of 6" to cut the annual weed flower/seed heads. Continue mowing every 3-4 weeks, as needed until late October, with a mowing height of 6". Most native perennials will not grow taller than 4-6" inches in the first year. Some vegetation such as Black Eyed Susan will grow taller but will not be adversely affected by cutting.
2. Refrain from mowing the meadow alone after late October until the next growing season. Mowing is extremely important for the first year to control weeds. It is strongly recommended not pull any weeds within the first year as such activity will disturb the native seedlings. These (typically annual) weeds will not present a problem and can be controlled by mowing. Once the meadow has become established the meadow species should out-compete the weeds, except for unusual situations which can be "spot" treated with herbicide, or hand-pulled. Inspection by a trained ecological restoration professional are recommended during the establishment period to advise on mowing regime and weed control.

B. Second Growing Season

1. Around April 1 -15 (following the first growing season), the meadow should be mowed to a height of 3-4" and raked lightly to expose the small plants and some soil. Remove the mowing debris if possible. Mowing should only be performed twice throughout the second growing season to a height of 12 inches, which should be sufficient to control annual and

biennial weeds. Timing of mowing should correspond to the bloom and seed cycles of biennial weeds such as Sweet clover, Burdock, and Queen Anne's Lace. Rhizomatous weeds such as Canada thistle, Canada goldenrod, and Reed canary grass can be spot-treated or physically removed as needed.

3.14 LONG TERM MEADOW MANAGEMENT: MOWING

A. It is recommended that the meadow be managed flail mowing every one to two years, mid-spring (Mid-late April) to a height of 3-4". Spring mowing will not adversely impact emerging native grasses and perennials and will help prevent establishment of woody species. Spring mowing also leaves native meadow plants intact over winter for added visual interest, wildlife habitat, and additionally provides a buffer from extreme weather and frost action on the soil. Mid-spring mowing also will cut some of the undesirable cool-season grasses that will likely invade the meadow. Always rake and remove the cuttings to expose the soil. If the new growth of the meadow gets over 12" before it is mowed, do not mow that year.

3.15 MEADOW PLUGGING

A. Edges of the plugged areas shall be smooth, and all plugged areas shall conform to the design cross sections and grade. At edges adjacent to curbs, paved areas, etc., top surface of earth in plugs shall be 1/2 in. below adjacent hard surface.

B. Plugs shall be placed and all planting operations completed within 72 hours following stripping from plug source bed.

C. Surface of completed plugged area shall be smooth. Plugs shall be pressed firmly into contact with soil bed by tamping or rolling, to eliminate air pockets. Plugs shall not be smothered with excess fill soil.

D Completed plugs shall immediately be watered sufficiently to uniformly wet the soil to at least 1 in. below the bottom of plugs bed.

E. Maintenance of plugged areas shall begin upon completion of planting and shall continue for 45 days thereafter, unless planting is not completed until after September 15, in which case maintenance shall continue until the June 15 following.

1. Watering
   a. Week No. 1: Provide all watering necessary for rooting of plugs. Soil on plugs pads shall be kept moist at all times. Perform watering daily or as necessary to maintain moist soil to a depth of 4 in. Watering shall be done during the heat of the day to prevent wilting.
   b. Week No. 2 and Subsequent Weeks: Water as necessary to maintain adequate moisture in the upper 4 in. of soil to promote deep root growth.

F. Plugged areas which fail to show a uniform stand of grass shall be replanted as often as necessary to establish an acceptable stand of grass.

1. Scattered bare spots, shall not exceed 1 sq. ft. each.

G. 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 replanted.

END OF SECTION

SECTION 329300

PLANTING

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. Provide all materials and equipment, and do all work required to complete the planting, 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. Section 312300, SITE EXCAVATING, BACKFILLING AND COMPACTING; Excavation and backfill.
2. Section 329115, PLANTING SOIL.
3. Section 329119, LANDSCAPE GRADING.
4. Section 329200, LAWNS AND GRASSES.

1.4 REFERENCES

A. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern. All standards shall include the latest additions and amendments as of the date of advertisement for bids.

1. American National Standards Institute, Inc. (ANSI):

Z60.1	American Standard for Nursery Stock (Sponsor: American Nursery and Landscape Association)
A 300	American National Standards for Tree Care Operations

2. American Society for Testing and Materials (ASTM):

C 136	Sieve Analysis of Fine and Coarse Aggregates
D 422	Particle-Size Analysis of Soils
E 11	Wire-Cloth Sieves for Testing Purposes
F 405	Corrugated Polyethylene (Pe) Tubing and Fittings

4. "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.

.5

A. Finish Grade: Elevation of finished surfaces.

~~Manufactured Loam Borrow: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil, loam borrow or planting soil.~~

1.6 SUBMITTALS

A. Samples: The following samples shall be submitted:

Material	Sample Size or Quantity
Mulch	1 ft.^{3}
Tree stake	24 in. length
Tree wrap	24 in. length

B. Manufacturer's Product Data: Manufacturer's product data shall be submitted for the following materials:
Aluminum sulfate
Antidessicant
Fertilizer
Fungicide
Herbicide
Insecticide
Tree wrap
Water retention additive
Mycorrhizal fungi innoculent

C. Certificates: Labels from the manufacturer certifying that the product meets the specified requirements shall be submitted for the following materials:
Compost

Commercial fertilizer
Limestone

1.7 SOURCE QUALITY CONTROL

A. Identification of plant materials shall be as named in "Hortus Third".

B. Selection of Plant Materials: Contractor shall submit to Architect a complete list of all proposed nurseries including location, contact #, plant list for each nursery, all proposed substitutions, credits and/or additional charges. No tagging will occur until this list is complete and submitted. Contractor shall be responsible for delays if list is not submitted complete and in advance of proposed tagging dates.

1. Inspect all nursery materials to determine that the materials meet the requirements of this section. Proposed materials shall be flagged by the nurseries for review by the Contractor and the Architect.
2. Schedule with the Architect a time for viewing plant material at the nursery. Trips to nurseries shall be efficiently arranged to allow Architect to maximize viewing time. A minimum of six weeks shall be allowed for this viewing prior to time that plants are to be dug.
3. Architect may choose to attach seal to each plant, or representative samples.
4. Viewing and/or sealing of plant materials by the Architect at the nursery does not preclude the Architect's right to reject material at the site of planting.
5. Architect will provide a maximum of two (2) tagging trips. Additional tagging trips (time and expense) shall be paid for by the Contractor.

C. Plant Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished for the Project. Take photographs from an angle

depicting true size and condition of the plant to be provided. Include a scale rod or other measuring device in each photograph. Include a minimum of three photographs for each species to be furnished. Photographs shall show actual material available for selection. Clearly identify photographs with botanical name, size and source nursery.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful establishment of similar plantings with highly technical soil installations. Installer shall provide evidence of the following credentials:

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. Experience: Five years' experience in landscape installation in addition to requirements in Division 01 General Requirements."
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
4. 3 projects similar scale and similar components within last 5 years
5. 3 references with phone numbers
6. 3 photos each for each reference project
7. Positive responses from all references
8. Reference project review by Architect and Owner within New Windsor, NY area.

B. Pesticide Applicator: State licensed, commercial.

1.9 PLANT MATERIAL QUANTITIES

A. In the event of a discrepancy in plant material quantities between the Drawings and the Plant List(s), the larger quantity shall be required.

1.10 UNAVAILABILITY OF PLANT MATERIALS

A. Before changes or substitutions can be made due to unavailability of plant material, submit satisfactory evidence that the Contractor has advertised for a one month period in a trade journal such as the "American Nurseryman", (Tel. 312-427-7339 and Fax: 312-427-7346), with no response, or has undertaken other methods of locating plant material acceptable to the Architect.

1.11 DELIVERY, STORAGE, AND HANDLING

A. 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. Trees shall not be transported when daytime air temperatures are below 20°.

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 Architect, notify the Architect at least two 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, if requested.

B. Storage: Unless specific authorization is obtained from the Architect, unprotected 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 moist, not be allowed to freeze, and their solidity carefully preserved.
2. Both the duration and method of storage of plant materials shall be subject to the approval of the Architect.

C. Handling of Plant Materials: Exercise care in handling plant materials to avoid damage or stress.

1.12 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. Plants with roots dried out, large branches broken, balls of earth broken or loosened, or areas of bark torn shall be subject to rejection by the Architect.

C. Rejected plants shall be removed from the area of work and replaced with same species of the required size and quality.

1.13 DIGGING/PLANTING SEASONS

A. Planting Restrictions and Seasons: Plant during one of the following the following periods, weather permitting. Coordinate planting periods with maintenance periods to provide required maintenance.

1. Spring Planting
   a. Deciduous trees and shrubs: March 15 to May 1.
   b. Evergreen trees and shrubs: March 30 to May 15.

c. Bareroot Trees: April 1 – May 7.
d. Groundcovers: April 15 to May 30.
e. Ornamental Grasses: April 15 to May 30.
f. Plants: After danger of frost between April 15 to June 1.
g. Bulbs: Do not plant in Spring.

2. Fall Planting
   a. Deciduous trees and shrubs: October 15 to November 30.
   b. Evergreen trees and shrubs: September 1 to October 15.
   c. Groundcovers: September 1 to October 15.
   d. Ornamental Grasses: September 1 to October 15.
   e. Plants: September 1 to October 15 or first frost.
   f. Bulbs: September 1 to November 30.
3. The following are fall planting hazards and shall be planted in the Spring only. Planting at times other Spring Season shall be done at Contractor's risk and shall not relieve Contractor of warranty obligations.
   a. Trees.
4. Execute the actual planting of plant material during periods within these seasons as determined by weather conditions, by acceptable practice in the locality of the project, or as may be approved by the Architect.

B. Plant frost-tender trees only after danger of frost is past or sufficiently before frost season to allow for establishment before first frost. Do not plant in frozen ground.

C. Planting Seasons: Planting shall only be performed when weather and soil conditions are suitable for planting the material specified, in accordance with locally accepted practice, approval of the Architect, and to maintain the Contractor's guarantee.

1.14 ACCEPTANCE FOR SUBSTANTIAL COMPLETION

A. The Architect shall inspect all work of this Section for Acceptance for Substantial Completion upon receipt of written notice of completion by the Contractor. The request shall be received at least ten calendar days before the anticipated date of inspection.

B. Acceptance of plant material by the Architect shall 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 shall recommend that Acceptance for Substantial Completion of the work of this Section be given by the Owner.

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.

1.15 MAINTENANCE

A. The Contractor shall maintain plant material until the completion of the one year Guarantee Period and Final Acceptance of work, as described in this Section.

1.16 GUARANTEE

A. Plants shall be guaranteed for a period of one year after the date of Acceptance by the Owner. However, under no conditions shall the Guarantee Period include less than 2 full growing seasons.

1. 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 plants shall extend for an additional one 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. At the end of the guarantee period, and no less than five days prior to final inspection, staking and guying materials, and tree wrap and ties shall be removed from the site.

1.17 FINAL INSPECTION AND FINAL ACCEPTANCE

A. At the end of the guarantee period, the Architect shall, upon receipt of 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. Final Inspection shall not be conducted while plants are in a dormant state.

C. Upon completion and reinspection of full repairs or replacements necessary in the judgment of the Architect at that time, the Architect shall 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 and their root balls shall conform to ANSI Z60.1.

B. Plants 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 for the species between height and spread. The Architect will be the final arbiter of acceptability of plant form.

1. Shade Trees: Single-stem trees with straight trunk, well-balanced crown, and intact leader, of height and caliper indicated, complying with ANSI Z60.1 for type of trees required.
2. Small Trees: Branched or pruned naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1; stem form.

3. Multistem Trees: Branched or pruned naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1; stem form.
4. Deciduous Shrubs: Form and Size: Deciduous shrubs with not less than the minimum number of canes required by and measured according to ANSI Z60.1 for type, shape, and height of shrub.
5. Coniferous Evergreens: Form and Size: Normal-quality, well-balanced, coniferous evergreens, of type, height, spread, and shape required, complying with ANSI Z60.1.
6. Coniferous Evergreens: Form and Size: Specimen-quality, exceptionally heavy, tightly knit, symmetrically shaped coniferous evergreens.
7. Broadleaf Evergreens: Form and Size: Heavy, well-balanced, broadleaf evergreens, of type, height, spread, and shape required, complying with ANSI Z60.1.

C. Plants shall be healthy and vigorous, free of disease, insect pests and their eggs, and larvae.

D. Plants shall have a well-developed fibrous root system.

E. 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.

F. Plants shall meet the sizes indicated on the Plant List. Plants larger or smaller than specified may be used only if accepted in writing by the Architect.

G. 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.

H. Plants shall not be pruned before delivery.

I. 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 all plants prior to delivery to the site, being careful not to restrict growth.

J. Plants indicated as "B&B" shall be balled and burlapped.

1. Unless otherwise permitted by the Architect, plants shall be nursery grown.
2 Plants shall be grown for at least two years under climatic conditions similar to those in the locality of the Project.
3. Nursery grown plants shall be dug in the current planting season. No heeled in plants or plants from cold storage that were dug in the previous season shall be accepted.

K. Container grown plants shall be well rooted and established in the container in which they were grown. They shall have grown in the container for a sufficient length of time for the root system to hold the planting medium when taken from the container, but not long enough to become root bound. Container grown plants exceeding the sizes indicated in ANSI Z60.1 shall have containers which are not less than 75% of the ball sizes for comparable B&B plant material. Each container plant shall be inspected and circling roots loosened or pruned as needed.

1. Any trees grown in pots, including pot-in-pot culture, will be rejected.

L. Canes or Trunk(s) and Branches:

1. Very well formed and sturdy with distinct leader and no crotches that may interfere with growth of leader. Trees with included bark in crotches shall be avoided.
2. Branching well spaced and uniformly distributed both vertically and around the circumference to form a well balanced plant.
3. Scars shall be free of rot and not exceed ¼ the diameter of the wood beneath in greatest dimension unless completely healed (except pruning scars).
4. Pruning scars clean cut leaving little or no protrusion from the trunk or branch.

5. Graft union completely healed.
6. No mechanical or pest damage.
7. No extreme succulence.
8. Evidence of adequate twig growth in the past 2-4 years, and well-formed buds.

M. Foliage:

1. Densely supplied with healthy, vigorous leaves of normal size, shape, color and texture (except shrubs moved bare-root or deciduous shrubs when dormant).
2. One half of the foliage should be growing on the lower 2/3 of the trunk.
3. No chlorosis.
4. No more than 5% of total foliage affected by pest or mechanical damage.

N. Root System:

1. Sturdily established and evenly distributed.
2. Container grown plants shall be well developed and hold the soil ball together when removed from the container.
3. Container grown plants shall not be excessively rootbound (except if deliberately grown rootbound to produce a dwarf plant).

2.2 GROUND COVER PLANTS AND VINES

A. Ground Cover: Provide ground cover of species indicated, established and well rooted in pots or similar containers, and complying with ANSI Z60.1.

B. Fast-Growing Vines: Provide vines of species indicated complying with requirements in ANSI Z60.1 as follows:

1. Two-year plants with heavy, well-branched tops, with not less than 3 runners 18 inches (450 mm) or more in length, and with a vigorous well-developed root system.
2. Provide field-grown vines. Vines grown in pots or other containers of adequate size and acclimated to outside conditions will also be acceptable.

2.3 PLANTING SOIL – PLANTS

A. Refer to Section 329115, PLANTING SOIL.

2.4 LIMESTONE

A. Limestone shall be an approved agricultural limestone containing no less than 50% of total carbonates, and 25% total magnesium with a neutralizing value of at least 100%. The material shall be ground to such a fineness that 40% will pass through a No. 100 U.S. Standard Sieve, and 98% will pass through a No. 20 U.S. Standard Sieve. The lime shall be uniform in composition, dry and free flowing, and shall be delivered to the site in the original unopened containers, each bearing the manufacturer's guaranteed analysis. Any lime which becomes caked or otherwise damaged making it unsuitable for use, will be rejected.

2.5 ALUMINUM SULFATE

A. Aluminum sulfate shall be unadulterated and shall be delivered in containers with the name of the material and manufacturer and net weight of contents.

2.6 WATER

A. Water shall be suitable for irrigation and shall be free from ingredients harmful to plant life.

2.7 MYCORRHIZAL FUNGI INNOCULANT

A. Mycorrhizal Fungi Innoculant shall be three ounce (3 oz.) premeasured dry formulation packets, such as Mycor Tree Saver Transplant®, as manufactured by Plant Health Care, Inc., Pittsburgh, PA, or approved equal. Packets shall contain, as a minimum: one thousand (1000) live spores of Vesicular-Arbuscular fungi, including: *Entrephosphora columbiana*, *Glomus clarum*, *Glomus etunicatum*, and *Glomus sp.;* seventeen million five hundred thousand (17,500,000) live spores of Ectomycorrhizal fungi, including: *Pisolithus tinctorius*; biostimulants including *Yucca schidigera* extract; soluble sea kelp extract derived from *Ascophylum nodosum*; humic acids; and acrylamide copolymer gel as a water absorbent medium.

1. Apply at each tree pit three (3) three-ounce (3 oz.) packets added to the top six to eight inches (6” to 8”) of backfill soil added and thoroughly mixed to distribute the inoculant in accordance with manufacturer’s printed instructions.

2.8 MULCH

A. Mulch shall be a 100% fine-shredded pine bark or double shredded, aged hardwood mulch, typical to the Windsor area, of uniform size and free from rot, leaves, twigs, debris, stones, or any material harmful to plant growth. Bark shall have been shredded and stockpiled no less than six months and no more than two years before use. No chunks 3 in. or more in size, and thicker than 1/4 in. shall be left on site.

2.9 GUYING AND STAKING MATERIALS

A. Wood Stakes: Straight, sound, rough sawn lumber 2"+ diameter, cedar stakes with bark on, tops chamfered 1/2", length 8-10 ft. Wire for staking shall be 12 gauge steel.

B. Wire for Guying: Galvanized steel 1 x 19 preformed 3/16 in. diameter. Thimbles and nicopress clips shall be used for connections and splices.

C. Turnbuckles: ¼” x 7-3/4” Galvanized steel with a 2-1/2” in. lengthwise opening fitted with eyebolts, as manufactured by Crown Bolt Inc., or approved equal.

D. Hose: High quality braided rubber hose, 3/4 in. diameter and suitable length, black in color.

E. Strapping: Arbortie, manufactured by DeepRoot Green Infrastructure, LLC, 530 Washington Street, San Francisco, CA 94111Tel: 800 458 7668 or 415 781 9700; Fax: 800 277 7668 or 415 781 0191, or approved equal.

F. Below Grade Rootball Tiedown: Arborguy by GreenBlueUrban; https://www.greenblue.com/na/products/arborguy/, or approved equal.

2.10 WRAPPING MATERIAL

A. Tree wrapping material shall be equal to the following:

1. Osnaburg Cloth, 4-7/8 in. wide, unbleached, pinked on both edges, manufactured by The Carnegie Textile Co., 1734 Ivanhoe Road, P.O. Box 10276, Cleveland, OH 44110.
2. Tree wrap shall be secured to the trunk using bio-degradable tape suitable for nursery use and expected to degrade in sunlight in less than two years after installation.
3. Option: Arbor Tape, supplied by American Arborist Supplies, 882 S Matlack Street, Unit A, West Chester, PA 19382: Phone: 800-441-8381/610-430-1214; Fax: 610-430-8560; E-mail Address: info@arborist.com, or approved equal.

2.11 ANTIDESICCANT

A. Antidessicant shall be an emulsion specifically manufactured for plant protection which provides a protective film over plant surfaces which is permeable enough to permit transpiration. Antidessicant shall be delivered in manufacturer's sealed containers and shall contain manufacturer's printed instructions for use.

B. Antidessicant shall be equal to the following:

Product	Manufacturer
Wilt-Pruf	Wilt-Pruf Products, Inc. P.O. Box 469 Essex, CT 06426
Winter Shield	Rockland Corporation

2.12 FUNGICIDE

A. Fungicide shall be "Bordeaux Mix", manufactured by Hi-Yield, or approved equal.

2.13 INSECTICIDE

A. Insecticide shall be LESCO Sevin Brand SL, #019106, for broad spectrum control for most trees, shrubs and ornamentals, manufactured by LESCO, Rocky River, OH 44116, or approved equal.

2.14 POST-EMERGENT HERBICIDE

A. Herbicide shall be QuikPRO™ herbicide, formulated as a water-soluble granule and packaged in easy-measure bottles, complete weed control, manufactured by Monsanto, or approved equal.

2.15 PRE-EMERGENT HERBICIDE

A. Herbicide shall be LESCO Ornamental Herbiicide 5G, pre-emergent grassy and selected broadleaf weed control for ornamental plants, nursery stock and ground covers, #019515, manufactured by LESCO, Rocky River, OH 44116, or approved equal.

2.16 EDGING

A. Steel edging shall be Border Concepts Edging, "Border King", manufactured by Border Concepts, Inc., P.O. Box 471185, Charlotte, NC 28247 or approved equal. Steel edging shall be shop fabricated, 1/4 in. thick x 5 in. deep, primed and painted Black. Edging shall be furnished in 16 ft. lengths.

1. Steel edging shall have slotted holes for staking steel edging every 30 in. o.c.
2. Steel stakes shall be 15 in. long, tapered.
3. Provide manufacturer's end stake and splicer unit.
4. Provide manufacturer's standard touch-up paint for in field touch-up of scratched or marred areas..

2.17 TREE WATERING SYSTEM

A. Tree watering system shall be 20 gallon Treegator® , a slow release watering system for new trees., capable of delivering a high volume of water directly to the root system of a newly planted tree with no run-off or evaporation, manufactured by Spectrum Products, Inc., Youngsville, North Carolina, 27596; supplied by PlanetGreenSpot.com PO Box 674 Pasadena, MD 21123, Tel. 888.574.6348.

2.18 WATER RETENTION ADDITIVE

A. Water Retention Additive for application at time of planting shall be a granular polyacrylamide polymer of a potassium base and not a sodium base that slowly releases moisture into the root zone such as Terra Sorb, as manufactured by Plant Health Care, Inc., 440 William Pitt Way, Pittsburgh, PA, or approved equal.

1. Apply at each tree in non-irrigated areas Water Retention Additive in three (3) ounces or the amount specified by Water Retention Additive manufacturer’s printed instructions.

PART 3 EXECUTION

3.1 PREPARATION OF PLANT MATERIALS

A. Immediately before digging and following consultation with the Architect, spray all evergreen or deciduous trees in full leaf with Transplant Biostimulant, applying an adequate film over trunks, branches, twigs and foliage and apply Transplant Biostimulant to the root ball area

B. Dig, and ball and burlap (B&B) plants with firm, natural balls of earth, of depth and diameter not less than that recommended by the American Standard for Nursery stock. Plants moved with a ball will not be accepted if the ball is cracked or broken before or during planting operation. Remove all grass, weeds and accumulated soil resulting from nursery cultivation from the top of the root ball prior to digging so that the original trunk flare shows on top of the root ball.

C. Use only natural burlap and jute twine. Do not use synthetic fibers or wire to ball and burlap root balls. Wire baskets will be acceptable if removed in accordance with these specifications.

D. All plant material in transit or temporary stored shall be covered with burlap or similar covering to keep plants from drying out.

E. Ship and store bare root material in refrigerated trucks and storage areas. Keep roots moist and cool until time of planting.

F. If the construction schedule requires trees over 3 ½" in caliper to be planted in the fall, that are of a species considered to be difficult to transplant in the fall, these trees shall be root pruned the previous spring in the nursery.

1. The Architect will determine tree species to be root pruned.
2. A trench shall be dug around the tree at the limit of the proposed root ball to a minimum depth of 24" and back-filled.
3. A 3" high saucer shall be built around the tree outside the edge of the trench.
4. The tree shall be guyed or braced.
5. The tree shall be watered as necessary through the summer.
6. When the tree is dug in the fall, the digging shall be done using methods that preserve the new root growth growing in the soft soil of the trench.
7. Root pruning, when required, shall be done at no additional cost to the Owner, except for owner pre-purchased trees.

3.2 EXAMINATION OF SUBGRADE

A. Examine subgrade and rough grading before planting. Alert Architect to unacceptable rough grading or subgrade conditions.

3.3 DECOMPACTION OF PLANTING AREAS

A. After subgrade levels have been reached and immediately prior to placing planting soils, the entrie subgrade area shall be loosened to a minimum depth of 12 inches utilizing the bucket of a backhoe or equivalent equipment.

B. Any subgrade areas which have become heavily compacted (defined as exceeding 86% - 88% compaction ASTM D698 Standard Proctor) including, but not limited to, temporary parking areas, material stockpile areas, temporary roadways, construction areas, areas shown on the plans, or areas identified by Architect shall be deep-scarified. Immediately prior to placing soils, heavily compacted areas shall be loosened to a minimum depth of 36 inches using the teeth of a backhoe or other suitable equipment. Frequency of compaction tests shall be one per 200 square feet.

C. Using a wide-track bulldozer size D-5 or smaller, compact the scarified subgrade to 86% - 88% compaction ASTM D698 Standard Proctor. Contractor shall provide shovel dug test pits to the full depth of the mitigation, where located per the direction of the Architect, in order for the Architect to review whether the work has been done as required. Backfill the pits after the review(s).

D. Confirm that the subgrade is at the proper elevation and that no further earthwork is required to bring the subgrade to proper elevations. Provide a written report to Architect indicating that subgrade has been placed to the required elevations, has been decompacted according to the Contract Documents and is ready for inspection at least 3 days prior to placing planting soil. Perform no work of placing and spreading planting mixes until elevations have been confirmed and written report has been accepted by the Architect.

E. After the soils have been loosened and inspected, planting soil may be spread by using a wide track bulldozer size D-5 or smaller or may be dumped and spreada with bucket of a backhoe from the edge of the loosened area. No rubber-tired equipment or heavy equipmenmt except for small bulldozer shall pass over the subsoils (subgrade) after theyhave been loosened. If Contractor plans to utlilize such areas for any use of heavy equipment, this should be carried out prior to beginning the process of loosening soils or filling in that area, or it shall be rescarified to meet this specification requirement.

3.4 SOIL DRAINAGE/DETRIMENTAL SOILS

A. Test drainage of five planting pits in each area where trees afe being planted in locations as directed by the Architect. Pits shall be filled with water twice in succession. The time at which water is put into the pit for a second filling shall be noted. Architect shall then be notified of the time it takes for pit to drain completely. Planting operations shall not proceed until Architect has reviewed test drainage results.

1. To test drainage, dig a whole about 1 foot deep. Fill with water and allow it to drain completely. Immediately refill the pit and measure the depth of the water with a ruler. 15 minutes later, measure the drop in water in inches, and mulitply by 4 to calculate how much water drains in an hour.
   a. Less than 1 inch per hour is poor drainage, indicating the site may stay wet for periods during the year. Plants that don't tolerate poor drainage will suffer. 1 to 6 inches of drainage per hour is desirable. Soils that drain faster than 6 inches per hour have excessive drainage, and Architect may consider consider choosing plants that tolerate dry or drought conditions. Any tree pits not meeting these criteria shall be excavated to a depth of 4 ft. and backfilled with enriched subsoil.

B The Contractor shall notify the Architect in writing if the need for underdrainage can be eliminated. Submit proposal and cost estimate for correction of the conditions for Architect's approval before starting work.

C. In areas without underdrainage, soil percolation test shall be completed on every 1 of 3 plant pits, report and location map to be reviewed by Architect. Contractor shall remediate soils and retest until meeting specified infiltration rates.

3.5 LAYOUT OF PLANTING AREAS

A. Individual trees shall be located in the field as indicated on the Drawings for Architect’s approval prior to planting. Contractor shall provide one foreman, one loader with operator and two laborers to work with Architect 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 with Architect at a slow and deliberate pace in order to achieve the desired results.

B. Individual shrubs and perennials to be planted shall be laid out in plant beds by the Contractor in ample time to allow inspection by the Architect.

3.6 PREPARATION OF SUBGRADE

A. Refer to Section 329119, LANDSCAPE GRADING and Section 329115, PLANTING SOIL.

3.7 PLANT PIT EXCAVATION

A. Planting pits for trees and shrubs shall be excavated to the depth and dimensions indicated on the Drawings.

B. Excavation shall not begin until locations are approved by the Architect.

3.8 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. Stakes shall be driven every 30 in. o.c. along length of edging, .
2. Adjacent lengths of edging shall overlap 8 in.

3.9 PLACING PLANTING SOIL

A. Refer to Section 329115, PLANTING SOIL.

B. Finish Grading: Refer to Section 329119, LANDSCAPE GRADING.

3.11 PLANTING

A. Tree, shrub, and groundcover beds shall be excavated to the depth and widths indicated on the Drawings. Most plants are located within continuous soil volumes; See Soil Plans. Immediately following tree planting, the area surrounding each tree shall be amended with additional compost in the upper soil layer. Apply 4" compost on top of the planting soil within 10' of the rootball on all sides. Incorporate into the top 6-9" of soil by rototilling or discing. Where trees will be located within decked areas, complete compost amendment following soil placement and before installation of rodent deterrent fabric and deck framing. If the planting pit for any tree is dug too deep, soil shall be added to bring it to correct level, and the soil shall be thoroughly tamped. Walls of plant pits shall be dug so that they are sloped as shown on the Drawings, and scarified. Do not excavate compacted subgrades of adjacent pavement or structures.

B. Plants shall be set as indicated on Drawings. Plants shall be set so that the root flare is at, or slightly above, finished grade as indicated on the Drawings. Plants located in poorly drained soils shall be set 2 to 4 inches above finished grade, gradually sloping between the top of the root ball and the surrounding finished grade.

1. In play areas, and at Tree Planter Benches, trees shall be tied down with Below-Grade Rootball Tie Downs. In planting beds, trees shall be staked with wood stakes. Verify locations in field with Architect.

C. Plants shall be turned to the desired orientation when required by Architect.

D. Containerized plants shall be removed from container taking care not to damage roots. The side of the root ball shall be scarified to prevent root-bound condition before positioning in planting pit.

E. Prior to Placing in Pit: Cut away bottom of wire basket and bottom of wrap material.

F. Pits shall be backfilled with planting soil. Soil shall be worked carefully into voids and pockets, tamping lightly every 6 in.

1. When pit is two-thirds full, plants shall be watered thoroughly, and water left to soak in before proceeding.
2. At this time, ropes or strings on top of balls shall be cut and removed. Burlap or cloth wrapping shall be cut away from the top of the ball and slit down the sides Non-biodegradable ball wrapping and support wire shall be totally removed from ball and planting pit.
3. Wire baskets shall be completely cut away from sides of root ball, and removed from pit. Bottom of basket may remain.
4. Remove nursery plant identification tags.

G. Backfilling and tamping shall then be finished and a saucer formed around plant pits as indicated on the Drawings.

H. Saucer shall be filled with water and water left to soak in. Saucer shall then be filled with water again.

3.12 PERENNIALS AND GROUNDCOVERS

A. Set out and space plants as indicated on the Drawings. Amend top layer of soil as indicated on the Drawings.

B. Perennials: Check root ball after removing plant from its container. Encircling roots need to be gently loosened from the tight mat of root-bound plants. If roots are very dense at bottom of pot, slice off the bottom 1". If roots are seriously disturbed when planting, cut back some foliage to reduce the water stress that will occur. Plant at the same soil level as the plant was in its container.

C. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

D. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

E. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.13 TREE WATERING SYSTEM

A. Street trees shall be irrigated with Gator Bags, placed in quantity and location as recommended by manufacturer.

3.14 LIQUID BIOLOGICAL AMENDMENTS

A. In all new planting areas, create injection sites made every 2 feet in a grid pattern. If the viable root zone varies from this area, adjust the pattern accordingly. Each injection site shall have a 2-inch wide diameter by 8-inch deep column that will act as leaching fields during the planting process. After the liquid and aeration injection is completed, the injection columns shall be backfilled with a custom blend of long-term granular food sources that include 25% feathermeal, 75% humate plus corresponding mychorrizal spores.

B. Early spring injection for both Ecto and Endo Mychorrizal plants shall consist of 50% concentrated liquid Biological Amendment with 1/2 gallon per a 100 gallons of soluble kelp, humic acid and molasses (or fish hydrolysate).

3.15 FUNGICIDE

A. Immediately after planting, all trunks of deciduous trees shall be sprayed with fungicide, applied as directed by chemical manufacturer.

3.16 PRE-EMERGENT-HERBICIDE

A. Immediately after planting, pre-emergent herbicide shall be applied to ornamental shrub beds and and around base of trees, in strict accordance with chemical manufacturer's printed instructions.

3.17 POST EMERGENT-HERBICIDE

A. Upon the appearance of weeds within planted areas, pre-emergent herbicide shall be applied to ornamental shrub beds and and around base of trees, in strict accordance with chemical manufacturer's printed instructions.

3.18 INSECTICIDE

A. Upon the appearance of insect problems, all trunks of deciduous trees shall be sprayed with insecticide, applied as directed by chemical manufacturer.

3.19 WRAPPING

A. Trunks of deciduous trees shall be spiral wrapped to a minimum height of the first major branch. Wrap shall be applied from base up so that layers overlap and shed water. Secure at the top with flexible weatherproof tape, as specified.

3.20 STAKING AND GUYING

A. All trees shall be staked or guyed immediately following planting. Plants shall stand verticle and plumb after staking or guying.

1. Staking and Guying: Set vertical stakes and space to avoid penetrating root balls or root masses. Allow enough slack to avoid rigid restraint of tree. Stakes and guys shall be installed as indicated on the Drawings.

B. Below Grade Rootball Tiedown: install in accordance with manufacturer's printed instructions.

3.21 AERATION SYSTEM

A. Pipe shall be installed in position and at locations indicated on the Drawings.

B. Perforated pipe shall be fitted with pipe manufacturer's filter fabric "sock" prior to installation.

3.22 MULCHING

A. Mulch shall be applied as follows (entire area listed shall be mulched):

Plant Type	Mulch Area	Mulch Depth, in.
Tree	Saucer	3
Shrub	Saucer or Bed	3
Ground Cover	Bed	3

Mulch shall not be allowed to cover the base of trunks.

3.23 PRUNING

A. 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 Architect. Pruning procedures shall be reviewed with Architect before proceeding.

B. Pruning shall be done with clean, sharp tools. Cuts shall be made flush, leaving no stubs. No tree paint shall be used.

C. Dead wood, suckers, and broken, weak, interfering and badly bruised branches shall be removed.

3.24 MAINTENANCE OF PLANTING

A. Maintenance shall begin immediately after each plant is planted and shall continue until expiration of the one year Guarantee Period.

B. Maintenance shall consist of pruning, watering, cultivating, weeding, mulching, fertilizing, removal of dead material, repairing and replacing of tree stakes, tightening and repairing of guys, adjusting 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. Daily watering of 1 gal./caliper inch should be delivered to the root ball of each tree during the first summer after planting. Continue through fall, reducing frequency. For trees larger than 3 inch caliper, fill saucer with 6 – 8 gallons twice per week during hot, dry weather, and once per week during cooler, wetter periods. Refer to Irrigation Plans for plantings outside of automated irrigation zone.

D. Planting areas shall be kept free of weeds, grass, and other undesired vegetative growth.

E. Upon completion of the Guarantee Period, the Owner shall assume all maintenance activities.

END OF SECTION

SECTION 329448

STAINLESS STEEL PLANT SUPPORT

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 plant support system as shown on the drawings and/or specified herein, including but not necessarily limited to the following:

1. Stainless steel wire rope assemblies.

2. Stainless steel fittings, anchors, hardware and accessories.

1.3 QUALITY ASSURANCE

A. Manufacturer: Minimum 5 years' experience in manufacturing and supplying stainless steel plant support of the type required for this Project.

B. Installer Qualifications: Installer shall be experienced in performing work of this section and shall have specialized in installation of work similar to that required for this project

C. Performance Requirements: Provide stainless steel cable railing system and mounting hardware that have been manufactured and installed to meet or exceed specified performance criteria.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's product data, standard details, and installation instructions.

B. Shop Drawings: Submit shop drawings showing layout, sizes, critical dimensions, details and locations of accessories details, and installation of railing frame components. Include Details of rope attachment, tensioning methods, hardware, and tensioning and mounting methodology.

C. Samples: Submit samples of rope and each unique piece of hardware.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver in manufacturer's original, unopened, undamaged containers, identification labels intact.

B. Store materials protected from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer. Store cartons and panels in a secure location in a dry place at the project site.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

A. Manufactured and sold by: Jakob Rope Systems, 2665 NW 1st Ave, Boca Raton, FL 33431. Phone (516) 330-6502. Email: info@jakob-usa.com

B. Or approved equal.

2.2 STAINLESS STEEL PLANT SUPPORT SYSTEM

A. Cable Material:

1. Rope: AISI Type 316 4mm Ø 4mm stainless steel 6x7 + SE wire rope.

2. Fittings, Anchors, Hardware, and Accessories: AISI 304, 316 or 316L stainless steel.

3. Rope Style: As selected by the Architect.

B. Rope Fittings, Terminals and Tensioners

1. IK300-0400 stainless steel wire rope 4.0 mm, with RH/LH M6 x 20mm swaged internal thread ends and forks.

2. Vertical rod 3.7mm thick stock.

C. Support Components: Eye nut.

D. Clamps and Plant Supports: 90-degree cross clamp, stainless steel.

E. Anchors and Hardware:

1. Threaded rod (headless screw).

2. Provide anchoring devices per manufacturer's instruction appropriate to the substrate being attached to.

F. Length:

1. Provide optimum adjustment in both directions by calculating final tendon lengths with allowance for tensioning fittings with 2/3 open and with 1/3 of thread length engaged.

2. Measure tendon length from center of pin to center of pin, or center of eye to center of eye.

2.3 FITTINGS AND ACCESSORIES

A. Provide grommet, bushings, nuts, washers, turnbuckles, fittings and other components as required for system installation.

2.4 FABRICATION

A. Stainless steel cables and fittings shall be dimensioned and fabricated to specified size and labeled according to shop drawings and installer’s specifications.

B. Preassemble items in shop to greatest extent practicable to minimize assembly at project site. Disassemble units only to extent necessary for shipping and handling limitations. Mark units for reassembly

2.5 FINISHES

A. Clean and/or descale cables and fittings in accordance with ASTM A380.

B. Passivate in accord with ASTM B912, to provide 330 grain satin finish (equiv. to #4 satin finish).

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify mounting conditions of previously installed surfaces to ensure that they are acceptable for product installation in accordance with manufacturer's instructions. Do not begin installation until back-up surfaces are in satisfactory condition.

3.2 PREPARATION

A. Supply items required to be cast into concrete or embedded in masonry with setting templates, to appropriate sections.

B. Take field measurements after permanent end terminations are in place and prior to preparation of shop drawings and fabrication, to ensure fitting of work.

3.3 INSTALLATION

A. Install cable plant support system in accordance with manufacturer's instructions and the approved shop drawings.

B. Provide anchorage devices and fittings to secure to in-place construction; including threaded fittings for concrete inserts, toggle bolts and through-bolts. Install all rope assemblies plumb, level, square, and taut.

C. Anchor system to mounting surfaces as indicated on the drawings.

D. Separate dissimilar materials with bushings, grommets or washers to prevent electrolytic corrosion.

E. Use manufacturer’s supplied mounting hardware.

F. Terminate and tension cable system in accordance with manufacturer’s instructions.

G. Ensure ropes are clean, and without kinks or sags.

H. After final adjustment provide tamper resistant lock-tight materials on all fittings.

3.4 CLEANING AND PROTECTION

A. Remove temporary coverings and protection of adjacent work areas.

B. Clean installed products in accordance with manufacturer's instructions before Owner's acceptance. Do not use chlorine-based or abrasive cleaners.

C. Remove from project site and legally dispose of construction debris associated with this work.

D. Protect installed product from damage during subsequent construction activities.

END OF SECTION

SECTION 329643

TREE PROTECTION AND TRANSPLANTING

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 tree protection and transplanting as shown on the drawings and/or specified herein, including, but not necessarily limited to, the following:

1. Balling and burlapping existing trees to be transplanted.

2. Transport, unloading, and replanting of existing trees to be transplanted.

3. Protection of existing trees.

1.3 RELATED SECTIONS

A. Division 1 Section "Temporary Facilities and Controls" for temporary construction, protection facilities, and environmental protection measures for site demolition operations.

B. Division 1 Section "Execution Requirements."

C. Division 2 Section "Site Preparation, Demolition and Clearing" for existing soil removal, clearing & grubbing, removal and disposal of debris and/or obstructions interfering with new work and removal of existing above grade structures and/or site structures.

D. Earthwork - Section 312000, for fill and backfill materials, excavating, backfilling, site grading and existing site utility coordination.

1.4 SUBMITTALS

A. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and address of architects and owners, and other information specified.

B. Schedule indicating anticipated dates the work is to take place, confirmation of suitability of final locations for each location associated with tree transplanting.

C. Provide a report from the arborist illustrating the protection of existing tress that will be impacted by Construction for review by Owner and Landscape Architect.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who has completed landscaping work similar in material, design, and extent to that indicated for this Project and with a 20-year record of successful landscape establishment.

1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on the Project site during times that tree transplanting operations are in progress.

B. Tree Service Qualifications: An experienced tree service firm that has successfully completed tree transplanting work similar to that required for this Project and that will assign an experienced, qualified arborist to project site on a full-time basis during execution of the Work.

1. Arborist Qualifications: A New York State certified arborist with a minimum of twenty years experience.

2. Tree Pruning Standards: Comply with ANSI A300, "Trees, Shrubs and Other Woody Plant Maintenance – Standard Practices," and the "Standards of Shade Trees," current edition, as published by National Arborist Association, The Meeting Place Mall, Route 101, P.O. Box 1494, Amherst, NH 03031-1094.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in waterproof containers showing weight, analysis, and name of manufacturer. Protect materials from deterioration during delivery and while stored at site.

1.7 PROJECT CONDITIONS

A. Existing Utilities: See Division 1 Section “Execution Requirements” and Section 312000, Earthwork.

1.8 COORDINATION AND SCHEDULING

A. Coordinate transplanting of materials with the Landscape Architect. Deciduous trees shall be dug and transplanted in the early Spring while they are still dormant, or at other times as determined by or acceptable to the Landscape Architect.

1.9 PROTECTION OF EXISTING TREES AND VEGETATION

A. Protect existing trees and other vegetation indicated to remain in place against unnecessary cutting, breaking, or skinning of roots, skinning and bruising of bark, smothering of trees by stockpiling construction materials or excavated materials within drip line, excess foot or vehicular traffic, or parking of vehicles within drip line. Provide temporary guards to protect trees and other vegetation.

B. Water trees and other vegetation to remain within the limits of the contract work as required to maintain their health during the course of construction operations.

C. Provide protection for roots over 1-1/2" diameter cut during construction operations. Coat the cut faces with emulsified asphalt, or other acceptable coating, formulated for use on damaged plant tissues. Temporarily cover exposed roots with wet burlap to prevent roots from drying out; cover with earth as soon as possible.

D. Repair trees damaged by construction operations, in a manner acceptable to the Landscape Architect. Repair tree damage by a qualified tree surgeon.

1.10 WARRANTY

A. General Warranty: For operations associated with tree transplanting, warrant all transplanted materials for a period of one year from the date of transplant, against defects including death and unsatisfactory growth, except for defects resulting from abnormal

weather conditions unusual for warranty period, or incidents that are beyond Contractor's control.

1.11 MAINTENANCE

A. Maintenance shall include pruning, including removal of dead or broken branches and treatment of pruned areas or other wounds.

PART 2 PRODUCTS

2.1 MATERIALS

A. Organic Mulch: Organic mulch, free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:

1. Type: Dark brown in color, uniform in size, double shredded hardwood bark mulch.

B. Pruning Alcohol: Commercial ethyl alcohol or ethanol, 70-95%.

C. Anti-Desiccant: "Wilt-Pruf NCF" anti-desiccant by Wilt-Pruf Products, Inc., "Cloud Cover" by Easy Gardener, or approved equal conforming to the following:

1. 100% organic and biodegradable, and not damaged by freezing.

D. Trunk-Wrap Tape: Two layers of crinkled paper cemented together with bituminous material, 4 inches wide minimum, with stretch factor of 33 percent.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas of transplanting for conditions affecting performance of work of this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Verify locations of all underground utilities in the proposed planting areas.

3.2 PREPARATION

A. Root prune all trees to be transplanted in accordance with accepted horticultural practices.

B. Thoroughly water trees within 24-48 hours prior to transplanting.

C. Trees to be Transplanted: Immediately prior to transplanting trees shown as indicated, thin out each tree by one-third in accordance with acceptable horticultural practices, and as follows:

1. Perform pruning with sharp tools. Disinfect tools by dipping in alcohol at the commencement of the day’s operation and again after finishing each tree known to be diseased. Use fresh alcohol each day for this operation.

2. Prune to remove dead, weak, interfering, suckered, damaged, or unsightly twigs or branches in accordance with acceptable horticultural practice.

3.3 DIGGING

A. Prior to digging existing trees to be transplanted, spray with an approved anti-desiccant and prewater.

B. Prior to digging operations, obtain the Landscape Architect's approval of the proposed rootball perimeter of each tree to be transplanted.

C. Securely tie in tree branches starting at treetop and work down using 3-ply and 5-ply sisal twine. Tie each branch individually in such a way as not to bruise or break the branches.

D. Tag the north side of each tree trunk and transplant in new locations with the same orientation.

3.4 BALLING AND BURLAPPING OPERATIONS

A. Dig immediately before moving.

B. Dig to retain as many fibrous roots as possible.

C. Hand shape final rootball, prior to burlapping, to a diameter and depth suitable for the species and approved by the Landscape Architect.

D. Prune, with a clean cut, all projecting roots or root tips shredded by digging operations.

E. Cover the entire rootball, top and bottom inclusive, with burlap. Securely pin burlap to the rootball with eight-penny nails, or an approved equal.

F. Prior to lacing, fold the slack burlap neatly into pleats on the lower tapered part of the rootball and pin smoothly with eight-penny nails.

G. Drum-lace the rootball using 42 inches diameter manila rope for top and bottom and 1/4 inch diameter manila rope for vertical lacing.

3.5 TRANSPORTING TREE TO NEW LOCATION

A. Take all necessary precautions so as not to damage the tree trunk, break branches or loosen the rootball mass during transport of the tree.

B. Employ a crane and approved tree lifting equipment as in accordance with acceptable horticultural practices

C. Prevent the rootball from rolling.

D. Place burlap on trunk at points of contact where rope, straps, and cable touch trunk.

E. Transport the trees to a new location as approved by the Landscape Architect.

3.6 TRANSPLANTING TREE TO A TEMPORARY LOCATION

A. Transport the trees to the location previously agreed upon by the Landscape Architect and Contractor and after preparations for temporary storage have been completed.

B. Prepare temporary location: Excavate shallow trench and examine existing subgrade for conditions detrimental to plant growth such as debris and/or obstructions and adverse drainage conditions.

1. Contractor shall perform a percolation test as necessary or as directed by the Landscape Architect to determine whether the existing soil permeability is adequate.

C. Set trees side-by-side within trench and backfill with approved soil, compact lightly, covering all roots and burlap.

D. Water thoroughly while in temporary location as required. Mulch all trees with 2” depth of mulch and wrap as approved by the Landscape Architect.

3.7 CLEANUP AND PROTECTION

A. During transplanting, keep pavements clean and work area in an orderly condition.

B. Protect existing site features to remain from damage due to landscape operations, operations by other contractors and trades, and trespassers. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged landscape work as directed.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of it off the Owner's property.

END OF SECTION

SECTION 331000
WATER UTILITIES

PART 1 – GENERAL

1.01 DESCRIPTION

A. This Section specifies requirements for the proposed water utilities including water system piping, fittings, appurtenances, and services.

B. The work includes:

1. Furnishing and installation of water distribution pipe, valves and valve boxes, hydrants, pipe fittings, anchors, thrust restraints, and required accessories and connections to existing water systems.
2. Resetting existing hydrants and valve boxes to grade.
3. Relocation of existing hydrants, valves, and other appurtenances as required.
4. Furnishing and installing meter pit, backflow prevention assembly, pressure-reducing valves, and other related appurtenances.
5. Disinfecting and testing of the water system.

1.02 RELATED SECTIONS

A. Sections which directly relate to the work of this Section include:

1. Section 310000 – EARTHWORK
2. Section 033055 – CAST-IN-PLACE CONCRETE (SITE)

1.03 STANDARDS

A. AWWA – American Water Works Association

B. NFPA – National Fire Protection Association

1.04 COORDINATION WITH THE MUNICIPALITY

A. The municipal water department shall be notified prior to starting construction of any portion of the municipal water system.

B. The closing of valves necessary for making connections with existing municipal system will be done by the local Water Department employees, assisted by the Contractor. Sufficient notice shall be given the Water Department of planned connection. No allowance will be made for any delay in closing of valves. A 48-hour notice shall be given to residents or businesses affected by the shut-down and shall be done by the Contractor under the direction of the Engineer. The Water Department may require the work to be done at night during the low water use time period.

C. Contractor shall be responsible for furnishing and installing water pipes, fittings, valves, hydrants and other necessary equipment in accordance with the requirements of the municipal water and fire departments. Prior to ordering materials, the Contractor to obtain the latest copy of the municipal water department's standards and specifications and shall notify the Engineer immediately if any discrepancies are found between those requirements and the Contract Documents.

1.05 SUBMITTALS

A. Shop Drawings

1. Submit Shop Drawings or descriptive literature, or both, showing dimensions, joints, and other details of all materials to be furnished. Shop Drawings shall be submitted to the Engineer for approval prior to ordering materials.

B. As-Built Drawings

1. Submit As-Built Drawings upon completion and acceptance of work.
2. As-Built Drawings shall be complete and shall indicate the true measurements and locations, horizontal and vertical of all new construction. As-Built Drawings shall include a minimum of three (3) ties to each gate valve box from fixed permanent objects. As-Built Drawings shall also contain any additional information required by the municipality, and shall be stamped with the seal of a licensed land surveyor and licensed professional engineer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Storage of pipe, fittings, valves, hydrants and other water line appurtenances on the site shall be in accordance with the manufacturer's recommendations, subject to the approval of the Engineer.

B. Care shall be taken in loading, transporting, and unloading of the water utilities materials to prevent injury to the pipe, fittings, valves, hydrants, and other water line appurtenances. Pipe, valves, or fittings shall not be dropped. All pipe or fittings shall be examined before laying and no piece shall be installed which is found to be defective. Any damage to pipe and fitting coatings shall be repaired as directed by the Engineer.

C. Pipe, fittings, valves, hydrants, and other water system appurtenances which are defective from any cause, including damage caused by handling, and determined by the Engineer as unrepairable, shall not be used and shall be replaced at no cost to the Owner.

D. Pipe and all water system appurtenances that are damaged or disturbed through any cause prior to acceptance of the work shall be repaired, realigned, or replaced as required by the Engineer at no additional cost to the Owner.

1.07 LICENSED FIRE PROTECTION SPRINKLER SYSTEM CONTRACTORS

A. Fire protection and fire control systems, including both overhead and underground water mains, fire hydrants, and hydrant mains, standpipes and hose connections to sprinkler systems, sprinkler tank heaters, back flow preventers, air lines and thermal systems, hot water fire

protection systems and standpipes connected to sprinkler systems, shall be installed by contractors and personnel appropriately licensed.

PART 2 – PRODUCTS

2.01 GENERAL

A. The Drawings are diagrammatic only and are intended to indicate the extent, but not all details, of the system which shall be constructed. All materials are not shown; but the Contractor shall furnish and install all materials required for the complete system.

2.02 DUCTILE IRON PIPE

A. Ductile iron pipe shall be designed in accordance with ANSI A21.50/AWWA C150 and manufactured in accordance with ANSI A21.51/AWWA C151.

B. Ductile iron pipe shall be Pressure Class 350 furnished in 18-foot or 20-foot nominal lengths.

C. Pipes shall be cement-mortar lined in accordance with ANSI/AWWA C104/A21.4, except that the cement lining shall be double thickness.

D. The exterior of all pipe shall be factory coated with a double coat of asphaltic material conforming to ANSI/AWWA C151/A21.51.

E. Where called for on the drawings, and in accordance with part 3.07 of this section, restrained joint pipe shall be one of the following, or an approved equal:

1. American Ductile Iron Pipe FLEX-RING Restrained Joint Pipe [4 inches – 54 inches], manufactured of ductile iron, all in accordance with ANSI/AWWA C151/A21.51, pressure rating 350 PSI for sizes 4 inches through 24 inches and pressure rating 250 PSI for sizes 30 inches through 48 inches.
2. U.S. Pipe TR FLEX restrained push-on joint pipe [4 inches – 36 inches], manufactured in accordance with the requirements of ANSI/AWWA C151/A21.51, pressure rating 350 PSI for sizes 4 inches through 24 inches and pressure rating 250 PSI for sizes 30 inches through 36 inches.
3. U.S. Pipe FIELD LOK Gasket Instant Joint Restraint [4 inches – 24 inches], manufactured in accordance with the requirements of ANSI/AWWA C151/A21.51 for working pressure of 350 PSI.

2.03 POLYVINYL CHLORIDE PIPE (PVC) PRESSURE PIPE (AWWA C900)

A. Pipe and fittings for pressure systems shall be C900 polyvinyl chloride pipe (4-inch to 12-inch) as described in AWWA C900. The pipe shall be plain end or gasket bell end, Working Pressure Rated 235 psi (DR 18) with cast-iron-pipe-equivalent outside diameter.

B. Joints: Joints for pipe shall be push-on joints conforming to ASTM D3139. Joints between pipe and metal fittings, valves, and other accessories shall be push-on joints ASTM D3139, or compression-type joints/mechanical joints, ASTM D 3139 and AWWA C111/A21.11. Provide

each joint connection with an elastomeric gasket suitable for the bell or coupling with which it is to be used. Gaskets for push-on joints for pipe shall conform to ASTM F477. Gaskets for push-on joints and compression-type joints/mechanical joints for joint connections between pipe and metal fittings, valves, and other accessories shall conform to AWWA C111/A21.11 for push-on joints and mechanical joints.

2.04 DUCTILE IRON PIPE FITTINGS

A. All ductile iron pipe fittings shall conform to ANSI/AWWA C110/A21.10 gray and ductile iron standard fittings or ANSI/AWWA C153/A21.53-84 ductile iron compact fittings 3 inch through 16 inch. The ductile iron compact fittings shall be marked in accordance with Sec. 53-11, which states that the fittings shall have distinctly cast on them the identity of this standard, C153; the pressure rating, 350 psi; nominal diameter of openings; manufacturer's identification; the country where cast; the letters "DI" or word "Ductile"; and the number of degrees or fraction of the circle on all bends.

B. The type of fittings for pipe and valve connections shall be determined by the Contractor in accordance with the requirements shown on the Drawings prior to ordering the fittings.

C. All fittings shall be cement-mortar lined and coated as specified for pipe.

2.05 DUCTILE IRON PIPE COUPLINGS

A. Couplings and accessories shall be pressure rated at least equal to that of the pipe. Couplings shall be Dresser Style 253, Smith Blair 441 Style, or approved equivalent. The couplings shall be provided with corrosion resistant nuts and bolts.

B. Transition couplings for joining pipe of different diameters shall be Dresser Style 162, or approved equivalent. Coupling shall be provided with corrosion resistant nuts and bolts.

C. After assembly, all exterior surfaces including the bolts and nuts shall be completely coated with two coats of a heavy-duty protective asphaltic coating. The interior of the coupling shall be epoxy-coated. Epoxy coating shall conform to AWWA C550.

2.06 DUCTILE IRON PIPE JOINTS

A. Joints shall be either push-on or mechanical joints conforming to ANSI A21.11/AWWA C111. Push-on and mechanical joints shall be provided with required gaskets, lubricants and accessories conforming to ANSI A21.11/AWWA C111.

2.07 POLYETHYLENE ENCASEMENT

A. Polyethylene encasement shall be Class A polyethylene film, 8 mil thick, conforming to ANSI/AWWA C105/A21.5 for Polyethylene Encasement for Ductile-Iron Piping.

B. Polyethylene encasement of ductile iron pipe shall be within the limits shown on the Drawings and shall be installed in accordance with ANSI/AWWA C105/A21.5.

2.08 GATE VALVES

A. Gate valves shall be resilient seated conforming to the requirements of AWWA C509 or AWWA C515, solid wedge type valves conforming to the requirements of AWWA C500, of the type used by the municipal water department.

B. Gate valves shall be cast iron body, bronze mounted, resilient wedge, non-rising stem with O-ring type stuffing box for valves 3 inches to 16 inches in size.

C. Gate valves shall open to the right [clockwise] and have mechanical joint.

D. Bolts, studs, and nuts shall be made from a corrosion-resistant material such as low-zinc bronze, nickel copper alloy, or stainless steel.

E. Operating nut shall be 2 inches square at the base, tapering to 1-15/16 inches square at the top.

F. Post indicator valves, when indicated on the drawings, are used to actuate and indicate the opened or closed status of the installed value and indicator posts. Post indicator valves shall be listed by Underwriter's Laboratories, Inc. (UL) and approved by Factory Mutual Research (FM) and shall be of a manufacturer approved by the local utility company.

2.09 VALVE BOXES

A. Each gate valve shall be provided with a valve box and cover.

B. Valve boxes shall be of the adjustable, telescoping, heavy-pattern type designed and constructed to prevent the direct transmission of traffic loads to the pipe or valve.

C. Valve boxes shall be cast iron, asphalt coated with cast iron covers. The smallest inside diameter of the shaft shall not be less than 5-1/4 inches. The lower section of the box shall be designed to enclose the operating nut and stuffing box of the valve. Provisions shall be made for adjustment through at least 6-inches vertically while retaining a lap of at least 4 inches between sections.

D. Covers shall be close fitting and substantially dirt-tight. The top of the cover shall be flush with the top of the box rim. The word WATER shall be cast in the top surface of the cover.

2.10 TAPPING SLEEVE AND VALVE

A. Tapping sleeve and valve shall meet the requirements of AWWA and shall be of the bolted-sleeve type with a mechanical joint connection to the existing water pipe and flanged end outlets for connecting the tapping valves. The tapping sleeves shall be suitable for a working water pressure of 200 psi and outlet flanges shall conform to the 125-pound American Standard with Cor-Ten or cadmium plated cast iron nuts and bolts. The tapping sleeve and valve shall be as manufactured by Mueller Company, or approved equivalent.

2.11 THRUST RESTRAINTS

A. Thrust restraints (cement concrete thrust blocks, clamps and tie rods, and restrained joints) shall be installed in accordance with the details shown on the Drawings and per manufacturer's recommendations.

B. The Contractor shall discuss with the Engineer the method[s] to be used to restrain thrust prior to installing fittings and hydrants. Test pits may be required in areas of existing utilities to determine the exact location and dimensions of thrust restraints required.

C. Restrained joint assemblies for mechanical fittings shall be EBAA Iron Sales MEGALUG Series 1100, or approved equivalent, and shall be rated for 350 PSI [3 inches – 16 inches] or 250 PSI [18 inches – 48 inches].

D. Concrete for thrust blocks shall have a minimum 28-day compressive strength of 3,000 psi.

E. The use of boulders in lieu of concrete thrust blocks or mechanical restraints is not allowed.

2.12 CORPORATION STOPS AND CURB STOPS

A. Corporation stops shall be Mueller 300 ball type corporation valves or equivalent with a compression-type fitting, on the outlet end. The inlet end should be threaded per local water department requirements.

B. Curb stops shall be Mueller 300 ball valve curb stop or approved equivalent, with compression-type fittings, on both ends.

C. Stops shall be sized to receive the service tubing without the use of enlargement/reduction fittings.

2.13 SERVICE BOXES

A. Service boxes shall be cast iron improved extension type with arch pattern base. Covers shall be held in place with bronze bolts and the word WATER shall be cast into the top surface of the cover. Service box shafts shall have a minimum inside diameter of 2-1/2 inches. Service boxes shall be as manufactured by Mueller Co., or approved equivalent.

2.14 WATER SERVICE

A. Services two inches or smaller shall be ASTM B88 copper water tubing, Type K, for underground water service and shall be in accordance with ANSI/AWWA C800.

B. Water service fittings including couplings and adapters, check valves and service saddles shall be in conformance with ANSI/AWWA C800, Underground Service Line Valves and Fittings. Joints in copper tubing shall be made with three part compression couplings or an approved equal.

C. Services 3 inches and greater shall be ductile iron pipe in accordance with Section 2.02 above.

D. Services less than 3 inches that are installed with plastic pipe where the utility allows, shall be polyethylene plastic tubing, SDR 9, PE3408 rated for 200 psi at 73.4°F in accordance with ASTM D2737. The outside diameter shall be the same as copper tubing (CTS). Stainless steel inserts shall be used at all connections.

2.15 UNDERGROUND PIPE INSULATION

A. Whenever called for on the Drawings, or required for close clearance on structures, provide factory pre-insulated piping systems.

B. Casing pipe shall be PVC, ASTM D1784.

C. Insulation shall be polyurethane closed-cell foam completely encapsulated on each pipe segment by a heat resistant compressed rubber seal.

D. Manufacturer shall be Thermal Pipe Systems, 'Duc-Tite' for use with ductile iron water pipe.

PART 3 – EXECUTION

3.01 GENERAL

A. All water pipes, fittings, valves, hydrants, and other appurtenances shall be installed at the locations as shown on the Drawings.

1. The proposed location and vertical alignment may be altered to avoid conflicts with existing and proposed utilities, as approved by the Engineer.

B. Contractor shall verify the location, size, invert and type of existing pipes at all points of connection prior to ordering new utility materials.

3.02 LAYING DUCTILE IRON PIPE AND FITTINGS

A. Ductile iron pipe and fittings shall be installed in accordance with the requirements of ANSI/AWWA C600.

B. Each length of pipe shall be laid with firm, full and even bearing throughout its entire length, in a trench prepared and maintained in accordance with Section 310000 – EARTHWORK. The type of materials to be used in bedding and backfilling and method of placement shall conform to the requirements of Section 310000 – EARTHWORK.

C. All pipe shall be clean before laying. When laying is stopped for any reason, the open ends of the pipe shall be closed by watertight plugs or other approved means. If water is in the trench when work is resumed, the plug shall not be removed until the trench has been dewatered and all danger of water entering the pipe has been eliminated.

D. Fittings, in addition to those shown on the Drawings, shall be provided if required to avoid utility conflicts.

E. When cutting of pipe is required, the cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. Cut ends of pipe to be used with a push-on bell shall be beveled to conform to the manufactured spigot end. Cement lining shall be undamaged.

F. Maximum allowable deflection for pipe laid without fittings shall not exceed the allowable amount established by the pipe manufacturer and shall not exceed those shown in AWWA C600.

G. The pipe shall be laid with a minimum cover of below finished grade.

H. All piping shall be laid in the dry with the spigot ends pointing in the direction of flow. Installation shall proceed from the downstream to upstream in all cases.

3.03 JOINTING DUCTILE IRON PIPE

A. Push-on joints shall be made in strict accordance with the manufacturer's instructions. A rubber gasket shall be inserted in the groove of the bell end of the pipe and the joint surface cleaned and lubricated using the pipe manufacturer's suggested methods and materials. The plain end of the pipe to be laid shall be inserted in alignment with the bell of the pipe to which it is to be jointed and pushed home with a jack or by other means. After joining the pipe, a metal feeler gauge shall be used to make certain that the rubber gasket is correctly located and has not been twisted or otherwise displaced.

3.04 JOINTING MECHANICAL JOINT PIPE AND FITTINGS

A. Mechanical joints shall be made in strict accordance with the manufacturer's instructions. Mechanical joints shall be made by first cleaning the surfaces against which the gaskets will come in contact with a wire brush. The gasket, bell, and spigot shall be lubricated by washing with soapy water just prior to assembling the joint. After the nuts have been made up finger tight, the bottom nut, then top and then diametrically opposite nuts shall be progressively tightened. Bolts shall be tightened to the torques listed:

Bolt Size (Inches)	Range of Torque (Feet-Pounds)
5/8 inch	45 - 60
3/4 inch	75 - 90
1 inch	85 – 100

1. Under no conditions shall extension wrenches or a pipe over the handle of an ordinary ratchet wrench be used to secure greater leverage. After installation, a heavy bitumastic coating shall be applied to all bolts and nuts.
2. Restraining device shall be ductile iron and shall have dimensions such that it can be used with the standardized mechanical joint bell and tee-head bolts conforming to ANSI/AWWA A21.11 and ANSI/AWWA C153, latest revision.

3.05 LAYING OF PVC WATER PIPE

A. Installation of PVC Plastic Water Main Pipe and Associated Fittings: Unless otherwise specified, install pipe and fittings in accordance with Section 3.01 entitled "General"; and with the recommendations for pipe joint assembly and appurtenance installation in AWWA M23, Chapter 7, "Installation."

B. Jointing: Make push-on joints with the elastomeric gaskets specified for this type joint, using either elastomeric-gasket bell-end pipe or elastomeric-gasket couplings. For pipe-to- pipe push-on joint connections, use only pipe with push-on joint ends having factory-made bevel; for push-on joint connections to metal fittings, valves, and other accessories, cut spigot end of pipe off square and re-bevel pipe end to a bevel approximately the same as that on ductile iron pipe used for the same type of joint. Use an approved lubricant recommended by the pipe manufacturer for push-on joints. Assemble push-on joints for pipe-to-pipe joint connections in accordance with the recommendations in AWWA M23, Chapter 7, "Installation," for pipe joint assembly. Assemble push-on joints for connection to fittings, valves, and other accessories in accordance with the applicable requirements of AWWA C600 for joint assembly. Make compression-type joints/mechanical joints with the gaskets, glands, bolts, nuts, and internal stiffeners previously specified for this type joint; assemble in accordance with the applicable requirements of AWWA C600 for joint assembly, and with the recommendations of Appendix A of AWWA C111/A21.11. Cut off spigot end of pipe for compression-type joint/mechanical-joint connections and do not re-bevel. Assemble joints made with sleeve-type mechanical couplings in accordance with the recommendations of the coupling manufacturer using internal stiffeners as previously specified for compression-type joints.

C. Pipe Anchorage: Provide concrete thrust blocks for pipe anchorage, except where metal harness in indicated. Use concrete, ASTM C94, having a minimum 28 day compressive strength of 3,000 psi.

3.06 CONCRETE THRUST BLOCKS

A. Where pipes change horizontal and vertical direction, at hydrants, tees, and other fittings, and wherever abnormal thrust forces may developed, the Contractor shall construct thrust and anchor blocks as detailed on the Drawings. They shall be concrete, of minimum dimensions as detailed on the Drawings, or of adequate additional size to suit actual conditions to withstand pressures anticipated, and shall be founded in undisturbed soil.

B. Concrete for thrust blocks shall have a minimum 28 day compressive strength of 3,000 psi.

C. Fittings which do not use thrust blocks resting against natural occurring material with passive resistance pressure of 1,500 psf shall be installed with a restrained joint system as specified in Article 3.07.

3.07 RESTRAINED JOINTS

A. Pipe with restrained joints shall be installed in all areas where the pipe is within fill materials and also at locations shown on the Drawings. Restrained joints shall be installed at bends, reducers, tees, valves, dead ends, and hydrants. The minimum length of pipe to be restrained on either

side of the joint shall be as shown on the table below. The fittings of the new piping shall be for restrained joints, as marked on the Drawings.

Number of Joints to Restrain on either Side of Fitting

Fitting	Number of Joints to Restrain on Either Side of Fitting (Based on 18-Foot Pipe Length)
90 degree bend	3
45 degree bend	2
22-1/2 degree bend	2
Tee:	
Branch	3
Run	2

B. No restraining is required in the direction of the existing pipe if only a short length of it is exposed in the trench for making a connection.

C. Restrained joint assemblies for push-on pipe and fittings shall be made in strict accordance with the manufacturer's recommended installation procedures.

3.08 WATER/SEWER SEPARATION

A. When a sewer pipe crosses above or below a water pipe, the Contractor shall comply with these following procedures:

1. Relation to Water Mains
   a. *Horizontal Separation*: Whenever possible sewers shall be laid at a minimum at least 10 feet, horizontally, from any existing or proposed water main. Should local conditions prevent a lateral separation of 10 feet, a sewer may be laid closer than 10 feet to a water main if:
      1). It is laid in a separate trench, or if;
      2). It is laid in the same trench with the water mains located at one side on a bench of undisturbed earth, and if;
      3). In either case, the elevations of the top (crown) of the sewer is at least 18 inches below the bottom (invert) of the water main.
   b. *Vertical Separation*: Whenever sewers must cross under water mains, the sewer shall be laid at such an elevation that the top of the sewer is at least 18 inches below the bottom of the water main. When the elevation of the sewer cannot be varied to meet the above requirements, the water main shall be relocated to provide this separation or reconstructed with mechanical-joint pipe for a distance of 10 feet on each side of the sewer. One full length of water main should be centered over the sewer so that both joints will be as far from the sewer as possible.
   c. When it is impossible to obtain horizontal and/or vertical separation as stipulated above, both the water main and sewer shall be constructed of mechanical-joint cement lined ductile iron pipe or other equivalent based on watertightness and structural soundness. Both pipes shall be pressure tested by an approved method to assure watertightness or both pipes shall be encased in concrete.

3.09 GATE VALVES AND BOXES

A. Valves shall be set in firmly compacted and shaped soil. Where the soil in the trench subgrade is found to be soft, loose, freshly filled earth, unstable, or otherwise unsuitable as a base, the unsuitable material shall be excavated to such additional depth and width as required. The excavated area shall be backfilled with gravel or crushed stone, compacted, and shaped.

B. Valve boxes shall be set centered and plumb over the operating nuts of all valves. The top of each valve box shall be set to finished grade with at least 10 inches of overlap remaining between the upper sections for vertical adjustment. Minimum overlap for lower extension pieces shall be 4 inches.

C. Boxes shall be adequately supported during backfilling to maintain vertical alignment.

3.10 TAPPING SLEEVES AND GATE VALVES

A. Installation shall be made under pressure and the flow of water through the existing pipe shall be maintained at all times. The diameter of the tap shall be a minimum of 1/4 inch less than the inside diameter of the branch line.

B. The entire operation shall be conducted by workmen thoroughly experienced in the installation of tapping sleeves and valves, and under supervision of qualified personnel furnished by the manufacturer. The tapping machine shall be furnished by the Contractor.

C. The Contractor shall determine the location of the existing pipe to be tapped to confirm that interference will not be encountered from existing utilities or a joint or a fitting. No tap shall be made closer than 3 feet from a pipe joint.

D. Pipe upon which tapping sleeve is to be installed shall be thoroughly cleaned of all foreign matter with scraping tools and wire brushes to a minimum of six inches beyond each side of the sleeve. The cleaned area shall be washed with a hypochlorite solution. The interior of tapping valve shall also be washed with hypochlorite solution.

E. Tapping sleeves and valves with boxes shall be set vertically and squarely centered on the pipe to be tapped. Adequate support shall be provided under the sleeve and valve during the tapping operation. Thrust blocks shall be provided behind all tapping sleeves. the supporting earth around and under the valve and sleeve shall be compacted. After completing the tap, the valve shall be flushed to ensure that the valve set is clean.

F. Before backfilling, all exposed portions of any bolts used to hold the two halves of the sleeve together shall be heavily coated with two coats of bituminous paint equivalent to Bitumastic No. 50, by Koppers Company, Inc.

3.11 HYDRANTS

A. Hydrants shall be installed at the locations and in conformance with the details shown on the Drawings.

B. Each hydrant shall be set vertically and be properly braced. Hydrants shall be installed with thrust blocks or restrained joints as specified in Articles 3.05 and 3.06. Care shall be taken to ensure that thrust block concrete does not plug the hydrant's drain ports.

3.12 WATER SERVICES

A. Service Pipe: Care shall be exercised in placing and laying of services to prevent kinks or sharp bends and to prevent contact with sharp stones or ledge which would damage to the pipe. At least 6 inches of sand shall be placed adjacent to, under, and above the pipe, and no stone larger than 2 inches shall be placed over the pipe until the depth of backfill above the pipe is in excess of 1 foot.

B. Corporation Stop: Taps to the pipe shall be threaded and shall be made at the horizontal diameter of the main. The tap shall be made by means of a tapping machine manufactured for this purpose and supplied by the Contractor. The tap and drill shall be kept sharp and shall have threads matching those of the stop. Corporation stop threads shall be coated with sealing compound and the stop screwed firmly into the water with the key upward and the inlet end projecting at least 1/8 inch beyond the inside face of the pipe. Corporation stop shall be left in the on open position after installation of the service pipe.

C. Curb Stop and Curb Boxes: Curb stop and curb boxes shall be of a size equal to the size of the service pipe and shall be installed in the locations shown on the Drawings or as ordered by the Engineer. The boxes shall be set in a vertical position and flush with the proposed finish grade.

D. Ductile Iron Service Pipe: Ductile iron service pipe connections to the water pipe shall be made with tee fittings or tapping sleeves.

3.13 SEPARATION FROM STRUCTURES

A. Whenever possible, water pipes shall maintain a minimum distance of three (3) feet from underground adjacent unheated structures, such as manholes, catch basins, retaining walls, bridge abutments, parking garages, etc.

B. When spacing under 3.13A. above is not possible, Contractor shall provide insulated water pipe for a minimum of three (3) feet beyond the limits of the adjacent structure.

3.14 POLYETHYLENE ENCASEMENT

A. Installation of polyethylene encasement shall be in accordance with the recommended procedures contained in ANSI/AWWA A21.5/C105.

B. Care shall be taken during backfilling to prevent damage to polyethylene wrap. Backfilling shall be in accordance with AWWA C600.

3.15 PRESSURE TESTING

A. Hydrostatic and leakage test shall be conducted in accordance with AWWA Standard C600, and NFPA 24, Standards, except it shall meet the leakage rates stated in 3.15D. below as directed by the Engineer. Testing shall be conducted by a certified independent water testing company.

B. Conduct pipe tests after concrete thrust blocks have cured to the required minimum 28 day compressive strength of 3,000 psi. Fill pipe 24 hours prior to testing, and apply test pressure to stabilize system. Use only potable water.

C. Prior to pressure testing, the entire pipe section shall be flushed to remove any rocks or debris which may have inadvertently entered the pipe during construction.

D. Once the pipe section has been filled at normal pressure and all entrapped air removed, the Contractor shall raise the pressure to 200 psi or two times the operating pressure (whichever is greater) by a special pressure pump, taking water from a small tank of proper dimensions for satisfactorily measuring the rate of water pumped into the pipe. This pressure shall be maintained for a minimum of two hours, during which time the line shall be checked for leaks. Measured rate of water leakage shall not exceed the allowable leakage as follows:

1. Domestic water service pipes only, without attached fire service supply: Meet latest edition of AWWA C600 series leakage requirements for the type of pipe being installed.
2. Fire protection piping and domestic water service pipe with attached fire service piping: Meet latest edition of NFPA 24 leakage requirements or latest edition of AWWA C600 series leakage requirements for the type of pipe being installed, whichever criteria is more stringent.
3. Interior piping in vaults, buildings, etc. shall have zero leakage.
4. Should leakage exceed the above rates, the Contractor shall immediately locate the leak or leaks and repair them. Pipe will be accepted only when leakage is zero, or less than the allowable amount. Approval does not absolve the Contractor from responsibility if leaks develop later within the period of warranty.

3.16 DISINFECTION

A. Before being placed in service, all new water pipe shall be chlorinated in accordance with ANSI/AWWA C651 Standard for Disinfecting Water Mains.

B. The location of the chlorination and sampling points will be determined by the Engineer in the field. Taps for chlorination and sampling shall be installed by the Contractor. The Contractor shall uncover and backfill the taps as required.

C. The pipe section being disinfected shall be flushed to remove discolored water and sediment from the pipe. A 25 mg/l chlorine solution in approved dosages shall be inserted through a tap at one end while water is being withdrawn at the other end of the pipe section. The chlorine concentration in the water in the pipe shall be maintained at a minimum 25 mg/l available chlorine during filling. To assure that this concentration is maintained, the chlorine residual shall be measured at regular intervals in accordance with procedures described in Standard Methods and AWWA M12, Simplified Procedure for Water Examination, Section K.

D. During the application of the chlorine, valves shall be manipulated to prevent the treatment dosage from flowing back into the pipe supplying the water. Chlorine application shall not cease until the

entire pipe section is filled with chlorine solution. The chlorinated water shall be retained in the pipe for at least a twenty-four hour period. The treated water shall contain a chlorine residual throughout the length of the pipe section as indicated in AWWA C651.

E. Following the chlorination period, all treated water shall be flushed from the pipe section and replaced with water from the distribution system. Prior to disposal of treated water, the Contractor shall check with local authorities to determine if the discharge will cause damage to the receiving body or sewer and, if required, the Contractor shall neutralize the chlorinated water in accordance with Appendix B, AWWA C650. Bacteriological sampling and analysis of the replacement water shall then be made by the Contractor in full accordance with AWWA Specification C651. A minimum of three samples shall be taken by the Contractor at locations directed by the Engineer along the length of water pipe being chlorinated and sent to a state-approved private laboratory for analyses. The Contractor shall re-chlorine if the samples show presence of coliform, and the pipe section shall not be placed in service until all of the repeat samples show no presence of coliform.

F. Furnish Certificate of Disinfection Report to the Engineer.

G. The Contractor shall pay all costs for all testing, flushing, chlorinating; laboratory analyses, sampling, water supply, and municipal charges.

END OF SECTION 331000

SECTION 333900
SANITARY UTILITY SEWERAGE STRUCTURES

PART 1 – GENERAL

1.01 DESCRIPTION

A. This Section specifies requirements for sanitary utility sewerage structures for a gravity flow sewerage system.

B. The work includes furnishing and installing all pipe, fittings manholes, structures and appurtenances required for the proposed system to convey sewage by gravity flow conditions.

C. Work and materials shall be performed in accordance with the State Plumbing Code. Work within 10 feet of the building or those dedicated systems within the site shall conform to the New York State Plumbing Code.

1.02 RELATED SECTIONS

A. Sections which directly relate to the work of this Section include:

1. Section 033055 – CAST-IN-PLACE CONCRETE (SITE)
2. Section 310000 – EARTHWORK
3. Section 334000 – STORM DRAINAGE UTILITIES

1.03 SUBMITTALS

A. Materials List and Shop Drawings

1. Materials list of materials proposed.
2. Shop drawings for all material and structures prior to ordering materials.

B. As-Built Drawings

1. Submit As-Built Drawings upon completion and acceptance of work.
2. As-Built Drawings shall be complete and shall indicate the true measurement and location, horizontal and vertical, of all new construction. As-Built Drawings shall include a minimum of three (3) ties to each manhole from fixed permanent objects. As-Built Drawings shall also contain any additional information required by the municipality and shall be stamped with the seal of a licensed land surveyor and licensed professional engineer.

1.04 INSPECTION

A. The manufacturer/supplier is responsible for the provisions and all test requirements specified in ASTM D3034 for SDR 35 gravity pipe and ASTM D2241 for PVC pressure rated sewer pipe. In addition, all PVC pipe may be inspected at the plant for compliance with these specifications by an independent testing laboratory selected and paid by the Owner. The Contractor shall require the manufacturer's cooperation in these inspections.

B. Inspection of the pipe may also be made after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the specification requirements, even though pipe

samples may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall be removed from the site at once.

1.05 DELIVERY, STORAGE, AND HANDLING

A. All materials shall be adequately protected from damage during transit. Pipes shall not be dropped.

B. All pipe and other appurtenances shall be inspected before placement in the work and any found to be defective from any cause, including damage caused by handling, and determined by the Engineer to be unrepairable, shall be replaced at no cost to the Owner.

C. Storage and handling of pipes, manholes and other sewer system appurtenances shall be in accordance with the manufacturer's recommendations, subject to the approval of the Engineer.

PART 2 – PRODUCTS

2.01 POLYVINYL CHLORIDE PIPE (PVC)

A. Pipe and Fittings: Polyvinyl chloride pipe and fittings (4 inches to 15 inches) shall be Type PSM polyvinyl chloride (PVC) SDR 21 with full diameter dimensions conforming to the specifications for Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings, ASTM D3034.

B. Joints: PVC pipe shall have an integral wall bell and spigot push-on joint with elastomeric gaskets secured in place in the bell of the pipe. The bell shall consist of an integral wall section with a solid cross section elastomeric gasket, factory assembled, securely locked in place to prevent displacement during assembly. Elastomeric gaskets shall conform to ASTM D3212.

C. Spigot pipe ends shall be supplied with bevels from the manufacturer to ensure proper insertion. Each spigot end shall have an “assembly stripe” imprinted thereon to which the bell end of the mated pipe will extend upon proper joining of the two pipes.

2.02 DUCTILE IRON PIPE (GRAVITY)

A. Ductile Iron Pipe: ASTM A746, Extra Heavy type, bell and spigot end, with epoxy lining per manufacturer’s recommendation.

B. Ductile Iron Pipe Joint: ANSI A21.11, rubber gasket joint.

2.03 MANHOLES

A. Precast Concrete Units:

1. Structure: 4 foot minimum inside diameter precast concrete units (4,000 psi minimum compressive strength) with eccentric cone section tapering to 30-inch diameter, or flat top, and one pour monolithic base section conforming to ASTM C478. All units to be designed for HS-20 loading.
2. Precast Unit Joint: Preformed butyl rubber section joint conforming to ASTM C990.

3. The date of manufacture and the name or trademark of the manufacturer shall be clearly marked on the inside of each precast section.

B. Masonry Units:

1. Brick shall conform to ASTM C32, Grade SM for construction of inverts and adjusting manholes to grade.
2. Concrete block shall be solid block and conforming to ASTM C139.
3. Mortar shall be in conformance with ASTM C270, Type M. The mortar shall be composed of Portland cement hydrated lime, and sand, in the proportions of 1 part cement to 1/4 part hydrated lime, to 3-1/2 parts sand, by volume.
4. Cement shall be Type I or II Portland cement conforming to ASTM C150. Where masonry is exposed to salt water, Type II shall be used.
5. Hydrated lime shall be Type S conforming to ASTM C207.
6. Sand for masonry mortar shall conform to the gradation requirements of ASTM C144.

C. Manhole Frame and Cover: Grey iron casting conforming to ASTM A48, heavy duty, with the word SEWER embossed on cover. Letter size shall be three inches. Frame and cover shall be East Jordan Iron Works 2008Z/2006A or approved equivalent, with a minimum clear opening of 30 inches.

D. Pipe Connections: Flexible sleeve or rubber gaskets shall be as manufactured by Press-Seal, Trelleborg, A-Lok or approved equivalent.

E. Steps: Steps for steel reinforced copolymer polypropylene step with at least a 14-inch wide stepping surface conforming to ASTM C478.

2.04 GREASE TRAP

A. Precast Unit

1. Grease traps shall be made of precast concrete of the capacity and dimensions shown on the Drawings and as manufactured by Scituate Precast, or approved equivalent.
2. Precast sections shall be cured by an approved ASTM method and shall not be shipped nor subject to loading until the concrete compressive strength has attained 5,000 psi. Portland cement shall be Type II, ASTM C150.
3. Precast units shall be designed for the following loads and possible combinations thereof:
   a. H-20 loading, manhole riser with frame and cones, plus the weight of soil above.
   b. Weight of precast concrete structure.
   c. Initial handling and erection loadings.

B. Precast Unit Joints: Butyl rubber section joint conforming to ASTM C990.

C. Manhole riser sections, manhole steps, frames and covers shall be as specified in Section 2.04.

2.05 BITUMASTIC COATINGS

A. The entire exterior surface of all masonry and concrete (whether precast or cast-in-place) structures associated with sewerage systems, such as manholes, grease traps, holding tanks, tight tanks, septic tanks, aeration tanks, pump stations, valve pits, etc., shall receive two coats of waterproofing such as Carboline Bitumastic 300M as manufactured by Carboline Company, MasterSeal HLM 5000 as manufactured by BASF, Aqua-Safe Concrete Sealer as manufactured

by Bay Oil Company, or approved equal. Total thickness of waterproofing shall be a thickness of 14 mils (dry)and shall be applied per manufacturer's recommendations.

PART 3 – EXECUTION

3.01 EXCAVATION AND BACKFILLING

A. The type of materials to be used in bedding and backfilling and the method of placement shall conform to the requirements of Section 310000, EARTHWORK and the details shown on the Drawings.

3.02 PIPE INSTALLATION

A. All sewer pipe shall be laid accurately to the lines and grades shown in the Drawings and in conformance with pipe manufacturer's recommended procedures.

B. Notch under pipe bells and joints, where applicable, to provide for uniform bearing under entire length of pipe.

C. Laying Pipe: Each length of pipe shall be laid with firm, full and even bearing throughout its entire length, in a prepared trench. Pipe shall be laid with bells upgrade unless otherwise approved by the Engineer. Do not permanently support pipes on bells.

1. Every length of pipe shall be inspected and cleaned of all dirt and debris before being laid. The interior of the pipe and the jointing seal shall be free from sand, dirt and trash. Extreme care shall be taken to keep the bells of the pipe free from dirt and rocks so that joints may be properly lubricated and assembled. No pipe shall be trimmed or chipped to fit.
2. No length of pipe shall be laid until the proceeding lengths of pipe have been thoroughly embedded in place, to prevent movement or disturbance of the pipe alignment.
3. All piping shall be laid in the dry with the spigot ends pointing in the direction of flow. Installation shall proceed from the downstream to upstream in all cases.

D. Pipe Extension: Where an existing pipe is to be extended, the same type of pipe shall be used, unless otherwise approved by the Engineer.

E. Full Lengths of Pipe: Only full lengths of pipe shall be used in the installation except that partial lengths of pipe may be used at the entrance to structures, and to accommodate the required locations of service connection fittings.

F. Pipe Entrances to Structures: All pipe entering structures shall be cut flush with the inside face of the structure, and the cut ends of the pipe surface within the structure shall be properly rounded and finished so that there will be no protrusion, ragged edges, or imperfections that will impede or affect the hydraulic characteristics of the sewage flow. The method of cutting and finishing shall be subject to the approval of the Engineer.

G. Protection During Construction: The Contractor shall protect the installation at all times during construction, and movement of construction equipment, vehicles and loads over and adjacent to any pipe shall be performed at the Contractor's risk.

1. At all times when pipe laying is not in progress, all open ends of pipes shall be closed by approved temporary water-tight plugs. If water is in the trench when work is resumed, the

plug shall not be removed until the trench has been dewatered and all danger of water entering the pipe has been eliminated.

H. Water Pipe - Sewer Pipe Separation: When a sewer pipe crosses above or below a water pipe, the Contractor shall comply with the following procedures:

1. Relation to Water Mains
   a. *Horizontal Separation:* Whenever possible sewers shall be laid at a minimum at least 10 feet, horizontally, from any existing or proposed water main. Should local conditions prevent a lateral separation of 10 feet, a sewer may be laid closer than 10 feet to a water main if:
      1.) it is laid in a separate trench, or if
      2.) it is laid in the same trench with the water mains located at one side on a bench of undistributed earth, and if
      3.) in either case the elevation of the top (crown) of the sewer is at least 18 inches below the bottom (invert) of the water main.
   b. *Vertical Separation:* Whenever sewers must cross under water mains, the sewer shall be laid at such an elevation that the top of the sewer is at least 18 inches below the bottom of the water main. When the elevation of the sewer cannot be varied to meet the above requirements, the water main shall be relocated to provide this separation or reconstructed with mechanical-joint pipe for a distance of 10 feet on each side of the sewer. One full length of water main should be centered over the sewer so that both joints will be as far from the sewer as possible.
   c. When it is impossible to obtain horizontal and/or vertical separation as stipulated above, both the water main and sewer shall be constructed of mechanical-joint cement lined ductile iron pipe or other equivalent based on watertightness and structural soundness. Both pipes shall be pressure tested by an approved method to assure watertightness or both pipes shall be encased in concrete.

I. Sewer Pipes-Laser Installation: Sewer pipes shall be laid to required grades by use of a laser and target system, unless otherwise specifically approved in writing by Engineer.

3.03 PIPE JOINTS

A. All joints shall be made water-tight.

B. Pipe shall be jointed in strict accordance with the pipe manufacturer's instruction. Jointing of all pipe shall be done entirely in the trench.

1. Lubricant for jointing of PVC pipe shall be applied as specified by the pipe manufacturer. Use only lubricant supplied by the pipe manufacturer.
2. PVC pipe shall be pushed home by hand or with the use of bar and block. The use of power equipment, such as a backhoe bucket, shall only be used at the direction of the manufacturer.
3. Field-cut pipe ends shall be cut square and the pipe surface beveled to the size and shape of a factory-finished beveled end. All sharp edges shall be rounded off.

C. Jointing of ductile iron and cast iron pipe shall be in accordance with Section 331000, WATER UTILITIES.

D. Jointing of concrete pipe and reinforced concrete pipe shall be in accordance with Section 334000, STORM DRAINAGE UTILITIES.

3.04 MANHOLES

A. General Requirements: All manholes shall be built in accordance with the Details and in the locations shown on the Drawings.

1. Structures shall be constructed of brick masonry, precast solid concrete block, cast-in-place concrete, or precast concrete.
2. All masonry shall be installed by personnel experienced and skilled in this work, and any person not deemed to be such by the Engineer shall be removed and replaced by a person so qualified.
3. Manholes shall be constructed as soon as the pipe laying reaches the location of the manhole. Should the Contractor continue pipe laying without making provision for completion of the manhole, the Engineer shall have the authority to stop the pipe laying operations until the manhole is completed.
4. The Contractor shall accurately locate each manhole and set accurate templates to conform to the required line and grade. Any manhole which is mislocated or oriented improperly shall be removed and rebuilt in its proper location, alignment, and orientation at no additional cost to the Owner.

B. Foundations: All manholes shall be constructed on a 12-inch layer of compacted bedding material. The excavation shall be dewatered to provide a dry condition while placing bedding material and setting the base.

C. Masonry: All brick or concrete block shall be thoroughly wetted before laying.

1. The first course of masonry shall be embedded in the concrete foundation immediately after the foundation has been poured.
2. All masonry shall be laid in the flat position in a full bed of mortar, and all vertical and horizontal joints shall be filled solid with mortar. Vertical joints on each succeeding course shall be staggered. Joints shall be not less than 3/8-inch-wide or more than 1/2 inch wide. Joints on the inside of the structure shall be neatly struck and pointed.
3. The exterior and interior surface of the walls shall be plastered with a one-half inch (1/2 in.) coat of 1:2 cement mortar.

D. Invert: Brick invert channels shall be constructed in all manholes to provide a smooth channel for sewage flow through the structure and shall correspond in shape to the lower half of the pipe. At changes in directions, the inverts shall be laid out in curves of the longest possible radii tangent to the centerline of the sewer pipes at the manhole side. Shelves shall be constructed to the elevation of the highest pipe crown and sloped to drain toward the flow channel.

1. Special care shall be taken in laying brick inverts. Joints shall not exceed three-sixteenth inch (3/16 in.) in thickness and each brick shall be carefully laid in full cement mortar joints on bottom, side and end in one operation. No grouting or working in of mortar after laying of the brick will be permitted. Bricks forming the shaped inverts in manholes shall be laid on edge.
2. Invert channels shall be built for future extensions where shown on the Drawings and where directed by the Engineer.

E. Steps: Steps shall be installed in all manholes, spaced twelve inches (12 in.) on center vertically and set securely in place during the construction of the masonry wall. Precast sections shall be arranged such that internal steps are in alignment.

F. Precast Manholes: Precast manholes shall be installed only after shop drawings have been approved.

1. The top grade of the precast concrete cone section shall be set sufficiently below finished grade to permit a maximum of five and a minimum of two courses (laid in the flat position) of eight inch (8 in.) brick to be used as risers to adjust the grade of the manhole frame. Manhole frames shall be set on a grout pad to make a water-tight fit.
2. Grout fill lifting holes on all manhole sections.

3.05 CONNECTIONS TO EXISTING FACILITIES

A. General Requirements: The Contractor shall make all required connections of the proposed sewer into existing sewer system, where and as shown on the Drawings and as required by the Engineer.

B. Contractor shall verify the location, size, invert and type of existing pipes at all points of connection prior to ordering new utility materials.

C. Compliance with Requirements of Owner of Facility: Connections into existing sewer facilities shall be performed in accordance with the requirements of the owner of the facility. The Contractor shall comply with all such requirements, including securing of all required permits, and paying the costs thereof. The costs of making the connections in accordance with the requirements of the owner of the existing facility shall be included in the Contract Sum.

3.06 MANHOLE CONNECTIONS

A. Manhole pipe connections for precast manhole bases shall be flexible boot cast into the manhole wall. The stainless-steel clamp shall be protected from corrosion with a bitumastic coating.

B. Sewer manholes shall be constructed with drop connections when the proposed invert of the connection is at least 2 feet (2 ft.) above the manhole invert. Drop connections for differences of less than 2 feet (2 ft.) shall also be provided if required by the governing authority.

3.07 SERVICE CONNECTIONS

A. General Requirements: The Contractor shall make all required connections of the building sewer service pipes into the sewer system. Work shall include making the service pipe connections into the sewer system pipes or into the manholes located ten feet (10 ft.) outside of the proposed building lines. If stubs are constructed for later connection to the building pipes, the ends shall be sealed with watertight plugs.

B. Coordination with Building Contractor: The Contractor shall coordinate the work with the work of the building contractor to determine the exact location and elevation of the point of entry into the building.

C. Connection into Sewer System: Sewer service pipe connections to the pipe of the sewer system shall be made with fittings supplied by the pipe manufacturer.

1. The Contractor shall install 45 degree wye branch or 90 degree tee fittings in the sewer pipes at all locations where building sewer service pipe connections are shown on the Drawings. Connections of the sewer service pipes shall be made into the wye branches or tees by means of 45 degree bends. The connections shall be made thoroughly watertight

and concrete shall be placed under each connection to bear on undisturbed earth and firmly support the connection. Sewer chimneys shall be encased in concrete unless directed otherwise by the Engineer.

3.08 GREASE TRAP

A. Precast grease traps shall be installed in accordance with the manufacturer's recommendations. The precast base section shall be set on 12 inches of compacted gravel borrow placed on compacted subgrade. Joints of field assembled precast sections shall be waterproof. Manhole riser sections, frames and covers shall be installed as required.

3.09 LEAKAGE TESTS

A. General Requirements: The Contractor shall test the completed sewer system, including manholes and service connections, for leakage by infiltration, exfiltration, or low-pressure air exfiltration tests. Manhole structures may be tested by a low-pressure air vacuum test. The tests shall be conducted as approved by the Engineer. The Contractor shall furnish all necessary equipment, materials and labor for performing the tests.

1. The Contractor shall notify the Engineer at least 48 hours prior to the start of testing. Testing shall only be performed in the presence of the Engineer.
2. Sections of pipe tested for infiltration and exfiltration prior to completion of the Contract shall be subject to additional leakage tests, if warranted, in the opinion of the Engineer, prior to acceptance of the Work.

B. Infiltration and Exfiltration Testing: The test length intervals for either type of leakage test shall be approved by the Engineer, but in no event shall they exceed one thousand feet (1,000 ft.). Where sewer pipe is laid on steep grades, the length to be tested by exfiltration at any one time shall be limited by the maximum allowable internal pressure on the pipe and joints at the lower end of the line. The maximum internal pressure at the lowest end shall not exceed 25 feet of water or 10.8 psi.

1. The test period, wherein the measurements are taken, shall not be less than four (4) hours in either type of test.
2. Depending on field conditions, the following tests for leakage shall be employed:
   a. *Infiltration Test*: The test may be used only when ground water levels are at least five feet (5 ft.) above the top of the pipe for the entire length of the section to be tested during the entire period of the test. Ground water levels may be measured in an open trench or in standpipes previously placed in backfilled trenches during the backfilling operations. When standpipes are installed in the backfill for ground water measurement, the lower ends shall be satisfactorily embedded in a mass of crushed stone or gravel to maintain free percolation and drainage. Infiltration through joints shall be measured by using a watertight weir or any other approved device for volumetric measurement installed at the lower end of the section under test.
   b. *Exfiltration Test*: This test consists of filling the pipe with water to provide a head of at least five feet (5 ft.) above the top of the pipe or five feet (5 ft.) above ground water, whichever is higher, at the highest point of the pipe section under test, and then measuring the loss of water from the line by the amount which must be added to maintain the original level. In this test, the pipe must remain filled with water for at least twenty-four (24) hours prior to the taking of measurements. Exfiltration shall be measured by the drop of water level in a closed-end standpipe or in one of the sewer manholes available for convenient measuring. When a standpipe and plug

arrangement is used in the upper manhole of a section under test, a positive method of releasing entrapped air in the sewer shall be installed prior to taking measurements.

c. *Leakage Requirements*: The total leakage of any section tested shall not exceed the rate of 50 gallons per day per mile per inch of nominal pipe diameter. For purposes of determining the maximum allowable leakage, manholes shall be considered as sections of 48-inch diameter pipe, five feet (5 ft.) long, and the equivalent leakage allowance shall be 2.25 gallons per manhole per 24 hours.

C. Low-Pressure Air Exfiltration Testing

1. The sewer pipes and service pipes shall be tested for leakage by the use of low-pressure air as approved by the Engineer. The test length shall not exceed one length of pipe between two manholes. Air test procedures may be dangerous and the Contractor shall take all necessary precautions to prevent blowouts.
   a. Pneumatic plugs shall have a sealing length equal to or greater than the diameter of the pipe to be tested.
   b. Pneumatic plugs shall resist internal test pressures without requiring external bracing or blocking.
   c. All air used shall pass through a single control panel.
   d. Three individual hoses shall be used for the following connections:
      1.) from control panel to pneumatic plugs for inflation;
      2.) from control panel to sealed line for introducing the low pressure air;
      3.) from sealed line to control panel for continually monitoring the air pressure rise in the sealed line.
2. The following testing procedures shall be explicitly followed:
   a. All pneumatic plugs shall be seal tested before being used in the actual test installation. One length of pipe shall be laid on the ground and sealed at both ends with the pneumatic plugs to be checked. Air shall be introduced into the plugs to 25 psig. The sealed pipe shall be pressurized to 5 psig. The plugs shall hold against this pressure without bracing and without movement of the plugs out of the pipe.
3. After the pipe has been backfilled and cleaned, pneumatic plugs shall be placed in the line at each manhole and inflated to 25 psi. Low-pressure air shall be introduced into this sealed line until the internal air pressure reaches 4 psi greater than the average back pressure of any ground water that may be over the pipe. At least two (2) minutes shall be allowed for the air pressure to stabilize.
   a. After the stabilization period (3.5 psi minimum pressure in the pipe), the portion of pipe tested shall be acceptable if the time required in minutes for the pressure to decrease from 3.5 to 3.0 psi (greater than the average back pressure of any ground water that may be over the pipe) is not less than the time indicated in the following table:

Pipe Size (in.)	Time (sec.)
4	0.190L
6	0.427L
8	0.760L
10	1.187L
12	1.709L
15	2.671L

Where L = length of pipe being tested

D. Vacuum Testing of Manholes: New sewer manholes shall be vacuum tested in accordance with procedure and standards in ASTM C1244.

E. Correction of Defective Work: If leakage exceeds the specified amount, the Contractor shall make the necessary repairs or replacements required to permanently reduce the leakage to within the specified limit, and the tests shall be repeated until the leakage requirement is met.

F. Compliance with Agency Requirements: In the event of conflict between the leakage test requirements specified herein with the leakage test requirements of agencies having jurisdiction over all or any portion of the sewer system installed under this Contract, the more restrictive requirements shall govern.

3.10 PIPE DEFLECTION MEASUREMENT

A. In accordance with ASTM D3034, no less than 30 days after completion of the PVC sewer pipe installation, the Contractor shall test the pipeline for deflection using a 'go/no-go' deflection mandrel having a minimum of nine evenly spaced arms or prongs. The 'go/no-go' gauge shall be hand pulled through all sections of the pipeline by the Contractor. The Contractor shall submit drawings of the 'go/no-go' gauge to the Engineer for approval prior to testing. Complete dimensions of the gauge for each diameter of pipe to be tested shall be in accordance with ASTM D3034.

B. Any section of pipe found to exceed 7.5 percent (7.5%) deflection shall be deemed a failed pipe and shall be excavated and replaced by the Contractor at his own expense.

3.11 CLEANING AND REPAIR

A. The Contractor shall clean the entire sewer system of all debris and obstructions. This shall include removal of all formwork from structures, concrete and mortar droppings, construction debris and dirt. The system shall be thoroughly flushed clean and the Contractor shall furnish all necessary hose, pumps, pipe and other equipment that may be required for this purpose. No debris shall be flushed into existing sewers, storm drains, and or streams.

B. All work of cleaning and repair shall be performed at no additional cost to the Owner.

3.12 FINAL INSPECTION

A. Upon completion of the work, and before final acceptance by the Engineer, the entire sewer system shall be subjected to a final inspection in the presence of the Engineer. The work shall not be considered as complete until all requirements for line, grade, cleanliness, leakage tests and other requirements have been met.

END OF SECTION 333900

SECTION 334000
STORM DRAINAGE UTILITIES

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section specifies requirements for furnishing and installing the site storm drainage utilities system, as indicated on the Drawings and as specified herein.

B. The work shall include but not be limited to the following:

1. Construction of the site storm drainage system, including underdrains, headwalls, flared end sections, underground stormwater detention facilities, and all appurtenances necessary to make a complete functioning system.
2. Connection of building drains from a point ten feet (10 ft.) outside building or structure foundations.
3. Construction of 'Dedicated Drainage Systems' on the site shall conform to the New York State Plumbing Code.

C. Work performed under this Section shall be subject to the General Conditions, Supplementary Conditions and Division 01 General Requirements of the Contract Documents.

1.02 RELATED SECTIONS

A. Carefully examine all Contract Documents for requirements which affect the Work in this Section. Other specification sections which directly relate to the Work of this section include, but are not limited to, the following:

1. Section 018900 – SITE CONSTRUCTION PERFORMANCE REQUIREMENTS
2. Section 033055 – CAST-IN-PLACE CONCRETE (SITE)
3. Section 312500 – EROSION AND SEDIMENTATION CONTROL
4. Section 310000 – EARTHWORK
5. Section 331000 – WATER UTILITIES
6. Section 333900 – SANITARY UTILITY SEWERAGE STRUCTURES

1.03 REFERENCE STANDARDS

A. References herein are made to the following Standards:

1. American Society for Testing and Materials (ASTM):

A48	Standard Specification for Gray Iron Castings
A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
C32	Standard Specification for Sewer and Manhole Brick
C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
C62	Standard Specification for Building Brick

C76 Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

C139 Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes

C144 Standard Specification for Aggregate for Masonry Mortar

C150 Standard Specification for Portland Cement

C207 Standard Specification for Hydrated Lime for Masonry Purposes

C270 Standard Specification for Mortar for Unit Masonry

C443 Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets

C478 Standard Specification for Circular Precast Reinforced Concrete Manhole Sections

C990 Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

D2665 Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings

D3034 Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings

D3350 Standard Specification for Polyethylene Plastics Pipe and Fittings Materials

D4884 Standard Test Method for Strength of Sewn or Bonded Seams of Geotextiles

F477 Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

F667 Standard Specification for 3 through 24 in. Corrugated Polyethylene Pipe and Fittings

F2418 Standard Specification for Polypropylene (PP) Corrugated Wall Stormwater Collection Chambers

2. American Association of State Highway and Transportation Officials (AASHTO):

M 274-87 Standard Specification for Steel Sheet, Aluminum Coated (Type 2), for Corrugated Steel Pipe

M 36 Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains

M 252-09 Standard Specification for Corrugated Polyethylene Drainage Pipe

M 294-17 Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in)

3. American National Standards Institute (ANSI):

A21.50 Thickness Design of Ductile Iron Pipe

A21.51 Ductile-Iron Pipe, Centrifugally Cast

4. American Water Works Association (AWWA):

C150 Thickness Design of Ductile Iron Pipe

C151 Ductile-Iron Pipe, Centrifugally Cast

1.04 SUBMITTALS

A. Shop drawings or descriptive literature, or both, showing dimensions, joint and other details of all materials proposed for the work. Shop drawings shall be submitted to the Engineer for approval prior to ordering material.

B. As-Built Drawings

1. The Contractor shall take measurements during construction of:
   a. Horizontal location of all drainage structures. Horizontal location shall be by survey location using the same coordinate system as the Project, or three (3) (minimum) ties to nearby permanent structures.
   b. Elevations of all inverts using Project Benchmarks.
2. As-Built Drawings shall be submitted to the Engineer upon completion of the work.
3. As-Built Drawings shall be complete and shall indicate the true measurement and location, horizontal and vertical, of all new drainage system construction. As-Built drawings shall include a minimum of three (3) ties showing the distance to each catch basin and manhole from fixed permanent objects. As-Built Drawings shall also contain any additional information required by the municipality and shall be stamped with the seal of a licensed Land Surveyor or licensed Professional Engineer.

1.05 QUALITY ASSURANCE

A. Work shall comply with the New York State Plumbing Code.

1.06 COORDINATION AND VERIFICATION

A. Coordinate the work with the termination of storm drain connections at buildings and connections to municipal systems, and trenching operations.

B. Prior to ordering materials, the Contractor shall field verify the location, elevations and size of all, existing pipe utility lines to remain, and proposed utility connections to existing utility systems.; any conflicts shall be reported to the Engineer for resolution.

1.07 DELIVERY, STORAGE, AND HANDLING

A. All materials shall be adequately protected from damage during transit. Pipes shall not be dropped.

1. All pipe and other appurtenances shall be inspected prior to installation and any found to be defective from any cause, including damage caused by handling, and determined by the Engineer to be unrepairable, shall be replaced at no cost to the Owner.
2. Storage and handling of pipes, manholes, catch basins, oil-grit separators, treatment units and other system appurtenances shall be in accordance with the manufacturer's recommendations.

1.08 INSPECTION

A. The manufacturer/supplier is responsible for the provision of all test requirements specified for each type of pipe. In addition, any pipe may be inspected at the plant for compliance with these

specifications by an independent testing laboratory selected and paid by the Owner. The Contractor shall require the manufacturer's cooperation in these inspections.

B. Inspection of the pipe may also be made after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the specification requirements, even though pipe samples may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall be removed from the site at once by the Contractor.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials for storm drainage utilities system shall be new and unused.

2.02 REINFORCED CONCRETE PIPE (RCP)

A. RCP shall comply with the requirements of ASTM C76. All pipe 18 inches and smaller shall be Class V. All other pipe shall be Class III unless indicated otherwise on the Drawings.

1. Joints for the RCP shall be the tongue and groove or bell and spigot type with rubber gasket conforming to ASTM C443.
2. Flared end pipe sections shall be constructed in conformance with ASTM C76, Class V requirements, and shall be supplied by the same manufacturer as the pipe.

2.03 CORRUGATED METAL PIPE (CMP)

A. CMP shall be: Corrugated Aluminized Steel Pipe, Type 2, 16 ga., and shall meet AASHTO M 274, and shall be and manufactured to meet the requirements of AASHTO M 36.

1. CMP shall be round pipe, pipe arch, or slotted drain as indicated on the Drawings.
   a. Slotted drain pipe shall have 1.75-inch-wide drain waterway opening and solid WEB spacer at 6 inches on center.
   b. CMP shall be as manufactured by Contech Construction Products, Inc., or approved equivalent.

2.04 PERFORATED STEEL PIPE UNDERDRAIN

A. Perforated Steel Pipe Underdrain shall conform to AASHTO M 36, Type III, Classes I, II or III and shall be ARMCO aluminized steel Type 2 (Hel-Cor) as manufactured by Contech Construction Products, Inc. or approved equivalent.

1. Fully perforated pipe shall be perforated with 3/8-inch diameter holes meeting the requirements of AASHTO M 36 Class 2.
2. Joints: Connecting bands for corrugated steel pipe shall be aluminized steel Type 2 Hugger Band with O-ring gaskets, double bolt bar and strap connector as manufactured by Contech Construction Products, Inc., or approved equivalent. Pipe shall conform to the manufacturer's requirements.

2.05 SLOTTED CORRUGATED PLASTIC PIPE

A. Slotted Corrugated Plastic Pipe materials, dimensions, physical properties and fabrication of pipe or tubing, couplings and fittings shall conform to AASHTO M 252.

B. Piping and fittings 3 inches to 24 inches in diameter shall conform to ASTM F667.

2.06 FILTER FABRIC

A. Filter Fabric for Underdrains shall be Mirafi 140N or approved equivalent.

B. Filter Fabric for Flared End Sections and Headwalls with Stone Protection shall be Mirafi 600X, or approved equivalent.

2.07 HIGH DENSITY CORRUGATED POLYETHYLENE (HDPE) PIPE

A. HDPE pipe and fittings shall be smooth interior, and meet the requirements of ASTM D3350. Four-inch through 10-inch diameter HDPE pipe shall meet the requirements of AASHTO M 252. Twelve-inch through 60-inch diameter HDPE pipe shall meet the requirements of AASHTO M 294, Types S.

B. Standard Fitting connections shall be fabricated to sizes shown on the Drawings.

C. Pipe joints and fittings shall conform to the requirements of AASHTO M 252 or AASHTO M 294. Pipe joints shall be Bell and Spigot soil tight joints and gaskets shall meet the requirements of ASTM F477. Fittings shall also be soil tight and gasketed.

D. Where indicated on the Drawings, HDPE pipe shall be slotted or perforated by the manufacturer prior to delivery to the job site. Coupling bands shall conform to the manufacturer's specifications. Couplers shall cover not less than one corrugation on each section of pipe.

2.08 POLYVINYL CHLORIDE (PVC) PIPE

A. PVC pipe and fittings shall comply with the requirements of ASTM D3034, rated SDR 35; and ASTM D2665 for Schedule 40 and Schedule 80 pipe and fittings. Pipe shall be continually marked with manufacturer's name, pipe size, cell classification, SDR rating, and ASTM D3034 classification.

2.09 DRAIN MANHOLES

A. Precast Concrete

1. Manholes shall be 48-inch minimum inside diameter, precast concrete units, 4,000 psi minimum compressive strength, with eccentric cone section tapering to 24-inch diameter and monolithic base section meeting the requirements of ASTM C478. All structures shall be designed for HS-20 loading and shall be sufficient diameter to accept the pipe penetrations indicated on the Drawings.
2. Precast unit joint seals shall be preformed butyl rubber O-ring type seals meeting the requirements of ASTM C990.

3. Openings for pipe and materials to be embedded in the walls of the manholes sections for joint seals shall be cast in the sections at the required locations during manufacture. Sections with incorrectly cast and patched pipe openings will be rejected.
4. Openings shall be cast into the manhole sections to receive entering pipes during manufacture. The openings shall be sized to provide a uniform 2-inch maximum annular space between the outside of the pipe wall and the opening in the riser for RCP. The openings shall be sized to accommodate flexible boot connections for all other pipe materials.
5. Manhole pipe openings shall be solidly filled with non-shrink mortar for RCP.
6. Manhole pipe connections for all other pipe materials shall be flexible boots as manufactured by Press-Seal, Trelleborg, A-Lok or approved equivalent.

B. Unit Masonry Construction:

1. Brick shall be sewer brick conforming to ASTM C32, Grade MS or approved equivalent.
2. Concrete block shall be solid block conforming to ASTM C139.
3. Mortar shall conform to ASTM C270, Type M. Mortar shall be composed of Portland cement, hydrated lime, and sand in the proportions of 1 part cement to 1/4 part hydrated lime to 3-1/2 parts sand by volume.
4. Cement shall be Type I or II Portland cement conforming to ASTM C150. Where masonry is exposed to salt water, Type II shall be used.
5. Hydrated lime shall be Type S conforming to ASTM C207.
6. Sand for masonry mortar shall conform to the gradation requirements of ASTM C144.

C. Steps for manholes shall be steel reinforced copolymer polypropylene plastic steps with at least a 14-inch wide stepping surface conforming to ASTM C478 and ASTM A615.

2.10 DRAIN MANHOLE FRAMES AND COVERS

A. Manhole frame and cover shall be grey iron casting conforming to ASTM A48, heavy duty, with the word "DRAIN" embossed on the cover. Letter size shall be three inches (3 in.). Frame and cover shall have a minimum clear opening of 24 inches and have a minimum weight of 475 pounds. Frame and cover shall be EJ 2114Z / 2110A , or approved equivalent.

2.11 CATCH BASINS AND DROP INLET

A. Precast catch basins and drop inlets shall be manufactured in accordance with ASTM C478, 4,000 psi minimum compressive strength) to the diameters and depths shown on the Drawings. All structures shall be designed for HS-20 loading. Precast unit joints shall be sealed with butyl rubber in accordance with ASTM C990.

B. Where required for hood, a slot and opening shall be cast in the catch basin wall for mounting the cast iron hood over the outlet pipe.

C. Openings at top of concrete structures where curb inlets are indicated shall be 24 inches by 27 inches.

D. When approved by the Engineer, catch basins and drop inlets may be constructed with brick or concrete block walls and poured reinforced concrete bases as an alternative to precast concrete units.

1. Brick and concrete block and other materials shall as specified under Drain Manholes.

2.12 CATCH BASIN FRAMES AND GRATES

A. Catch basin frame and grates shall be cast iron, conforming to ASTM A48, Class 30. Where located in accessible ways, grate openings shall meet the requirements of federal, state, and local regulations adopted under the Americans with Disabilities Act (ADA).

B. Single catch basin frame and grate shall be R-3403-A1, manufactured by Neenah Foundary Company or approved equivalent with four flanges, or with three flanges for use with gutter inlet or abutting vertical curb.

2.13 AREA DRAINS

A. Area drains shall be supplied with R-4380-4-2 cover or approved equivalent.

2.14 OUTLET CONTROL STRUCTURES AND HEADWALLS

A. Outlet Control Structures and Headwalls shall be made of concrete or precast concrete and shall be of the size, capacity, and dimensions indicated on the Drawings.

B. Precast sections shall be cured by an approved ASTM method and shall not be shipped nor subject to loading until the concrete compressive strength has attained 4,000 psi minimum and 28 days after fabrication. Portland cement shall be Type II, ASTM C150.

C. Precast units shall be designed for the following loads and possible combinations thereof:

1. H-20 loading, manhole riser with frame and cones, plus the weight of soil above and the soil loading due to the depth of the structure below finished grade
2. Weight of precast concrete structure
3. Initial handling and erection loading
4. Cast in place concrete shall be as specified under Section 033055 – CAST-IN-PLACE CONCRETE (SITE).

D. Construction joints shall be sealed with a butyl rubber-based sealant.

E. Manhole riser sections, manhole steps, frames and covers shall be as specified for precast concrete Drain Manholes.

F. Grates and grills for outlet structures, which are not manufactured cast iron standards, shall be hot dip galvanized iron units shop constructed to fit the dimensions indicated on the drawings. Safety bars shall be 60 ksi reinforcing steel.

2.15 SILT SACKS AND SEDIMENT CONTROL DEVICES

A. Silt Sacks and Sediment Control Devices shall be as manufactured by ACF Environmental, Inc.; or approved equivalent.

C. Material shall be a polypropylene geotextile fabric with strength per ASTM D4884.

2.16 TRENCH DRAIN

A. Trench drain shall be ACO K100 KlassikdrainTrench Drain System as manufactured by ACO Polymer Products, Inc., 9470 Pinecone Drive, Mentor, OH 44060 (800-543-4764), or approved equivalent.

1. The channels shall be made with chemically resistant polyester or vinylester resin polymer concrete with a minimum 28-day compressive strength of 11,000 psi and shall meet the testing requirements of ASTM C39.

B. Trench drain shall be heavy duty type designed for HS-20 loading.

C. Pre-cast polymer concrete trench drainage channel sections shall be set in cast-in-place concrete with a minimum 28-day compressive strength of 4,000 psi, using ASTM C150, Type II Portland cement.

D. Grates shall be longitudinal stainless steel. When located in accessible ways, grate openings shall meet the requirements of federal, state, and local requirements adopted under the American with Disabilities Act (ADA).

E. Each trench drain system shall include the following, all made by one manufacturer.

1. Channel
2. Catch basin
3. Inlet and outlet caps
4. Quicklock gratings

PART 3 - EXECUTION

3.01 GENERAL

A. Contractor shall verify the location, size invert and type of existing pipes at all points of connection prior to ordering new utility materials.

B. All pipe shall be laid accurately to the lines and grades indicated on the Drawings and in conformance with the pipe manufacturer’s recommendations.

C. As soon as the trench is excavated to the normal grade of the bottom of the trench, the Contractor shall immediately place the bedding material in the trench. The pipe shall be firmly bedded in the compacted bedding material accurately to the lines and grades shown on the Drawings.

D. Laying Pipe

1. Each length of pipe shall be laid with firm, full and even bearing throughout its entire length, in a prepared trench. Pipe shall be laid with bells upgrade unless otherwise approved by the Engineer.
2. Every length of pipe shall be inspected and cleaned of all dirt and debris before being laid. The interior of the pipe and the jointing seal shall be free from sand, dirt and trash. Extreme care shall be taken to keep the bells of the pipe free from dirt and rocks so that joints may be properly lubricated and assembled. No pipe shall be trimmed or chipped to fit.
3. No length of pipe shall be laid until the proceeding lengths of pipe have been thoroughly embedded in place, to prevent movement or disturbance of the pipe alignment.

4. Bedding shall be notched under pipe bells and joints where required to provide for uniform bearing under entire length of pipe.

E. Optimum moisture content of bedding material shall be maintained to allow required compaction density.

F. Where an existing pipe is to be extended, the same type of pipe shall be used, unless otherwise approved by the Engineer.

G. Only full lengths of pipe shall be used in the installation except that partial lengths of pipe may be used at the entrance to structures, and to accommodate the required locations of service connection fittings.

H. All pipes entering drainage structures shall be cut flush with the inside face of the structure, and the cut ends of the pipe surface within the structure shall be properly rounded and finished so that there will be no protrusion, ragged edges or imperfections that would impede the hydraulic characteristics of the stormwater flow. The method of cutting and finishing shall be subject to the approval of the Engineer.

I. The Contractor shall protect the installation at all times during construction. Movement of construction equipment, vehicles, and loads over and adjacent to any pipe shall be performed at the Contractor's risk.

J. At all times when pipe laying is not in progress, all open ends of pipes shall be closed by approved temporary watertight plugs. If water is in the trench when work is resumed, the plug shall not be removed until the trench has been dewatered and all danger of water entering the pipe eliminated.

3.02 RELATIONSHIP TO WATER MAINS

A. When a drain pipe crosses above or below a water pipe, the following procedures shall be utilized:

1. *Horizontal Separation*: Whenever possible drains shall be laid at a minimum of 5 feet horizontally from any existing or proposed water main. Should local conditions prevent a lateral separation of 5 feet, a drain may be laid closer than 5 feet to a water main if:
   a. It is laid in a separate trench, or if
   b. It is laid in the same trench with the water mains located at one side on a bench of undistributed earth, and if
   c. In either case the elevation of the top (crown) of the drain is at least 12 inches below the bottom (invert) of the water main.
2. *Vertical Separation*: Whenever drains must cross under water mains, the drain shall be laid at such an elevation that the top of the pipe is at least 12 inches below the bottom of the water main. When the elevation of the drain cannot be varied to meet the above requirements, the water main shall be relocated to provide this separation or reconstructed with mechanical-joint pipe for a distance of 10 feet on each side of the drain. One full length of water main should be centered over the drain so that both joints will be as far from the sewer as possible.
3. When it is impossible to obtain the horizontal and vertical separation stipulated above, both the water main and drain shall be constructed of mechanical-joint cement lined ductile iron pipe or other equivalent based on water tightness and structural soundness. Both pipes shall be pressure tested by an approved method to assure water tightness.

3.03 EXCAVATION AND BACKFILLING FOR PIPES

A. The type of materials to be used in bedding and backfilling and the method of placement shall conform to the requirements of Section 310000 – EARTHWORK, the details shown on the Drawings and the following.

B. Embedment materials are those used for bedding, haunching and initial backfill around pipes as illustrated on the Drawings.

1. All embedment materials should be free from lumps of frozen soil or ice when placed. Embedment materials should be placed and compacted at optimum moisture content

C. Trench Bedding: Material must be provided to insure proper line and grade is maintained. Unsuitable or unstable materials shall be undercut and replaced with a suitable bedding material, placed in 6 inch lifts. Other methods of stabilization, such as geotextiles may be appropriate and their use must be approved by the Engineer or Owner's Representative.

1. Provide a stable and uniform bedding for the pipe and any protruding features of its joints and/or fittings. The middle of the bedding equal to 1/3 of the pipe outside diameter should be loosely placed, with the remainder compacted to a minimum of 95 percent Modified Proctor Density.

D. Haunching: Proper haunching provides a major portion of the pipe's strength and stability. Exercise care to insure placement and compaction of the embedment material in the haunches. For larger diameter pipes (pipes greater than 30 inch diameter), embedment materials should be worked under the haunches by hand. Haunching materials shall be placed and compacted in 6 inch maximum lifts, compacted to 95 percent Modified Proctor Density.

E. Initial Backfill: The initial backfill shall be from the springline to 24 inches above the pipe to provide protection for the pipe from construction operations during placement of the final backfill and protect the pipe from stones or cobbles in the final backfill. Compact initial backfill per Section 310000 - EARTHWORK.

1. Flooding or jetting as a procedure for compaction are not allowed.

F. Final Backfill: The final backfill should be the same material as the proposed embankment or surface finishes. Generally, the excavated material may be used as final backfill. Placement should be as specified for the embankment. In lieu of a specification, the final backfill should be placed in 12 inch maximum lifts and compacted to a minimum 95 percent modified proctor density to prevent excessive settlement at the surface. Compaction should be performed at optimum moisture content.

G. Vehicular and Construction Loads: During construction, avoid heavy equipment loads (greater than 40,000 lbs. per axle) over the pipe. Additional temporary cover should be placed over the pipe for heavy construction load crossings. Hydrohammers or hoe-pak compactors may not be used over the pipe until at least 48 inches of cover have been provided.

3.04 PRECAST DRAIN MANHOLES, CATCH BASINS, AND DROP INLETS

A. Drain Manholes, Catch Basins, and Drop Inlets shall be constructed at the locations and to the lines, grades, dimensions and design shown on Drawings or as required by the Engineer.

B. Precast Concrete Units shall be installed in a manner that ensures watertight construction. All leaks in precast concrete structures shall be sealed. If required, precast concrete structures shall be repaired or replaced to obtain watertight construction.

C. Stubs shall be short pieces of pipe cut from the bell ends of the pipe. Stubs shall be plugged with brick masonry unless otherwise approved by the Engineer.

D. Drain Manhole inverts shall conform accurately to the size of the adjoining pipes.

1. Drain Manhole inverts shall be constructed of 3,500 psi concrete as shown the Drawings.
2. Inverts shall be laid out in smooth diameter curves of the longest possible radius to provide uniform flow channels.
3. Invert shelves shall be graded with a 1 inch drop per one foot length sloped from the manhole walls.

E. Drain Manhole steps shall be accurately positioned and embedded in the concrete when the section is cast. Precast reinforced concrete manhole sections shall be set vertical, with sections and steps in true alignment.

F. All holes in sections used for their handling shall be thoroughly plugged with rubber plugs made specifically for this purpose, or with mortar. The mortar shall be one part cement to 1-1/2 parts sand, mixed slightly damp to the touch, hammered into the holes until it is dense and an excess of paste appears on the surface, and finished smooth and flush with the adjoining surfaces.

G. Precast sections shall be level and plumb with approved joint seals. Water shall not be permitted to rise over newly made joints until after inspection and acceptance. All joints shall be watertight.

H. Openings which have to be cut in the sections in the field shall be carefully made to prevent damage to the riser. Damaged risers will be rejected and shall be replaced at no additional cost to the Owner.

3.05 CHANGE IN TYPE STRUCTURES

A. Where indicated on the Drawings, existing subsurface drain structures shall be converted to the new structure types in the following manner:

1. Catch Basins to Manholes
   a. Fill basin sump with 3,000 psi concrete and create new inverts at the elevations and sizes indicated and in accordance with specifications and details for new drain manholes.
   b. Provide and adjust to grade new drain manhole frame and cover.
   c. Stockpile existing frame and grade per Owner’s directions.
2. Manholes to Catch Basins or Drain Inlets
   a. Where a sump is indicated on the Drawings, replace existing manhole structure with new precast concrete catch basin structure.
   b. Where a sump is not indicated on the Drawings, replace existing frame and cover with new frame and grate and adjust to grade per these specifications and details for new catch basins.
   c. Stockpile existing manhole frame and cover per Owner’s directions.

3.06 BRICK MASONRY

A. Brick masonry structures shall be watertight. all leaks in brick masonry structures shall be sealed. all brick masonry shall be laid by skilled workmen.

B. All beds on which masonry is to be laid shall be cleaned and wetted properly. Brick shall be wetted as required to be damp, but free of any surface water when placed in the work. Bed joints shall be formed of a thick layer of mortar which shall be smoothed or furrowed slightly. Head joints shall be formed by applying a full coat of mortar on the entire brick end, or on the entire side, and then by shoving the mortar covered end or side of the brick tightly against the bricks laid previously. The practice of buttering at the corners of the brick and then throwing the mortar or crappings in the empty joints will not be permitted. Dry or butt joints will not be permitted. Joints shall be uniform in thickness and approximately 1/4 inch thick.

C. Brickwork shall be constructed accurately to the required structure dimensions and tapered at the top to the dimensions of the flanges of the cast-iron frames, as shown on the Drawings.

D. Joints on the inside face of walls shall be tooled slightly concave with an approved jointer when the mortar is thumbprint hard. The mortar shall be compressed with complete contact along the edges to seal the surface of the joints.

E. All castings to be embedded in the brickwork shall be accurately set and built-in as the work progresses.

F. Water shall not be allowed to flow against brickwork or to rise on the masonry for 60 hours after it has been laid, and any brick masonry damaged in this manner shall be replaced as directed at no additional cost to the Owner. Adequate precautions shall be taken in freezing weather to protect the masonry from damage by frost.

3.07 CONCRETE MASONRY UNITS

A. Concrete masonry units shall be soaked in water before laying. As circular concrete block walls are laid-up, the horizontal joints and keyways shall be flushed full with mortar. As rectangular blocks are laid-up, all horizontal and vertical joints shall be flushed full with mortar. Plastering of the outside of block structures will not be required. No structure shall be backfilled until all mortar has completely set.

3.08 MANHOLE STEPS

A. Steps shall be installed into the precast walls during manufacture.

B. Steps in brick masonry and concrete units shall be installed as the masonry courses are laid.

3.09 CASTINGS

A. Cast-iron frames for grates and covers shall be well bedded in cement mortar and accurately set to the proposed grades.

B. All voids between the bottom flange and the structure shall be completely filled to make a watertight fit. A ring of mortar, at least one-inch (1 in.) thick and pitched to shed water away from the frame shall be placed over and around the outside of the bottom flange. The mortar shall extend to the outer edge of the masonry all around its circumference and shall be finished smooth. No visible leakage will be permitted.

C. Structures within the limits of bituminous concrete pavement shall be temporarily set at the elevation of the bottom of the binder course. After the binder course has been compacted, the structures shall be set at their final grade. Backfill necessary around such structures after the binder course has been completed shall be made with 3,500 psi concrete.

3.10 CONNECTIONS TO EXISTING FACILITIES

A. The Contractor shall make all required connections of the proposed drainage system into existing drainage system, as indicated on the Drawings.

B. Connections into existing drainage system facilities shall be performed in accordance with the requirements of the Owner of the facility. The Contractor shall comply with all such requirements, including securing of all required permits, and paying the costs thereof.

3.11 MANHOLE CONNECTIONS

A. Manhole pipe connections for precast manhole bases shall be a tapered hole filled with non-shrink waterproof grout for RCP. Manhole connections shall be flexible boot cast into the manhole wall for HDPE, PVC, and DIP. The stainless-steel clamp shall be protected from corrosion with a bitumastic coating.

3.12 ROOF DRAIN OR SIMILAR CONNECTIONS

A. The Contractor shall make all required connections of the building drainage pipes into the site drainage system at locations and at distances from the buildings as indicated on the Drawings. If stubs are constructed for later connection to the building pipes, the ends shall be sealed with watertight plugs and marked with 2 x 4 risers for later location.

B. The Contractor shall coordinate the sitework with the building work to determine the exact location and elevation of the points of entry into buildings.

C. Roof drain connections to the site drainage system shall be made with fittings supplied by the pipe manufacturer.

3.13 TRENCH DRAINS AND SLOTTED DRAINS

A. Trench drain and slotted drain installation methods shall be in accordance with the manufacturer's recommendations and the details indicated on the Drawings.

B. The Contractor shall submit the manufacturer's written instructions for installation prior to installation, as required hereinbefore.

3.14 INFILTRATION SYSTEMS CONSTRUCTION

A. Infiltration systems shall consist of any of the following and combinations thereof:

1. Chambers, plastic or concrete pipes, etc.
2. Ponds constructed for this purpose.
3. Precast concrete leaching structures.

B. For the long-term function of the infiltration system, the Contractor shall:

1. Prevent the infiltration basin from being used as a construction sediment basin without prior approval of the Engineer.
2. Direct stormwater runoff from exposed surfaces away from the infiltration basin.
3. Ensure that construction equipment, vehicular traffic, parking of vehicles, and stockpiling of construction materials shall be outside of the infiltration system area.
4. Ensure that the soil at the bottom of the infiltration system excavation is not compacted or smeared.
5. Ensure that the perimeter of the infiltration system is staked and flagged to prevent the use of the area for activities that might damage the infiltration ability of the system.

3.15 CLEANING

A. The Contractor shall clean the entire drainage system of all debris and obstructions. Cleaning shall include removal of all formwork from structures, concrete and mortar droppings, construction debris, and dirt. The system shall be thoroughly flushed clean, and the Contractor shall furnish all necessary hose, pumps, pipe and other equipment that may be required for this purpose. No debris shall be flushed into existing drains, storm recharge chambers, storm drains and/or streams.

3.16 TESTING

A. Testing shall be done with a mandrel with a minimum length that is greater than the pipe diameter, and a minimum diameter of 90 percent of the pipe diameter. If the mandrel cannot be pulled through the pipe after seven (7) days of completed trench backfill, the pipe line shall be deemed unacceptable and the pipe lines shall be removed and replaced.

B. The Contractor shall make all necessary repairs or replacements required to permanently provide an open and structurally sound drainage system capable of supporting the anticipated loading from all sources throughout the year.

3.17 FINAL INSPECTION

A. Upon completion of the work, and before final acceptance by the Engineer, the entire drainage system shall be subjected to a final inspection in the presence of the Engineer. The work shall not be considered as complete until all requirements for line, grade, cleanliness, mandrel tests, and other requirements have been met.

END OF SECTION 334000

SECTION 334020
WARNING AND TRACER TAPE

PART 1 – GENERAL

1.01 WORK INCLUDED

A. This Section covers the furnishing, handling, and installation of warning and tracer tape, as called for on the Drawings.

1.02 SUBMITTALS

A. In accordance with requirements of General Specifications, submit the following:

1. One set of manufacturer's literature on the materials, colors and printing specified herein, shall be submitted to the Engineer for review.

1.03 LAWS AND REGULATIONS

A. Work shall be accomplished in accordance with regulations of local, county, state and federal agencies or utility company standards as they apply.

PART 2 – PRODUCT

2.01 ACCEPTABLE MANUFACTURERS

A. Tape shall be manufactured by: Terra-Tape and Terra-Tape D by Reef Industries, Houston, TX; or approved equal.

2.02 TAPE

A. Warning and tracer tape shall be at least 6 inches wide.

B. Tracer tape for non-ferrous pipe or conduit shall be constructed of a metallic core bonded to plastic layers. The metallic tracer tape shall be a minimum 5-mil thick and shall be located at a depth as indicated on the drawings.

C. Warning tape for ferrous pipe or conduit shall consist of multiple bonded plastic layers. The non-metallic tracer tape shall elongate at least 500% before breaking.

D. The tape shall bear the wording (or approved equal): 'BURIED DRAIN LINE BELOW' (with 'DRAIN' replaced by 'WATER', 'SEWER', 'ELECTRICAL', 'GAS', 'DATA' or 'TELEPHONE' as appropriate), continuously repeated every 30 inches to identify the pipe.

E. Tape colors shall be as follows as recommended by the American Public Works Association (APWA):

Electric	Red
Gas and Oil	Yellow
Communications	Orange
Water	Blue
Sewer and Drain	Green
Chemical	Red (not APWA)

PART 3 - EXECUTION

3.01 INSTALLATION

A. Warning and tracer tape shall be installed above the pipe or conduit it is to identify at depths as indicated on the Drawings.

B. Follow the manufacturer's recommendations for installation of warning and tracer tape.

END OF SECTION 334020

SECTION 334723
SUBSURFACE WASTEWATER DISPOSAL SYSTEM

PART 1 - GENERAL

1.01 WORK INCLUDED

A. The Work of this Section includes the installation of a new subsurface wastewater disposal system as shown on the Drawings and as specified herein.

B. Provide facilities, labor, materials, tools, equipment, appliances, transportation, supervision, and related Work specified in this Section and as shown on the Drawings.

1.02 RELATED SECTIONS

A. Carefully examine all of the Contract Documents for requirements which affect the Work in this Section. Other specification sections, which directly relate to the Work of this section include, but are not limited to, the following:

1. Section 312500 - EROSION AND SEDIMENTATION CONTROL

2. Section 310000 - EARTHWORK

3. Section 333400 – SANITARY UTILITY SEWERAGE STRUCTURES

1.03 REFERENCE STANDARDS

A. References herein are made in accordance with the listed specific standards of the following organizations and work under this Section shall conform to the latest edition, unless modified by these Specifications.

1. The American Concrete Institute (ACI).

2. American National Standards Institute (ANSI).

3. ASTM International (ASTM).

4. American Water Works Association (AWWA).

1.04 QUALITY ASSURANCE

A. Work under this Section shall comply with the federal, state, and local requirements for the design, installation, testing, and certification of an operational subsurface wastewater disposal system.

B. Work shall comply with local, state and federal electrical codes to provide ‘watertight and corrosion resistant’ installations.

1.04 SUBMITTALS

A. Shop Drawings: The Contractor shall submit shop drawings and equipment cut sheets for all items specified in this Section. Shop Drawings submittals shall include but are not limited to the following:

1. Gravity sewer pipe.
2. Pressure sewer pipe.
3. Perforated distribution lines.
4. Septic tank or other precast structure.
5. Dosing/pump tank.
6. Blower chamber (if required).
7. Valve chamber.
8. Control valves.
9. Air release valves.
10. Pumps and/or slide rail system.
11. Control panels and equipment.
12. Manholes.
13. Pipes.
14. Clean outs.
15. Frames and covers.
16. Wiring.
17. Conduit.
18. Vents.
19. Pipe supports.
20. Thrust blocks.
21. Laterals.
22. Wye connections.
23. Grease traps.
24. Waterproofing.
25. Electrical components.
26. Fittings.
27. Pressure gauges.
28. Access hatches.
29. Treatment units.
30. Leaching areas.
31. Manifolds.
32. Sealant.
33. Soils.
34. Stone.
35. Geosynthetics.
36. Any other structures and appurtenant items required by the Specifications or shown on the Drawings.

B. As-Built Drawings

1. As-Built Drawings shall indicate the true measurements and locations, horizontal and vertical, of the new sewerage system construction. As-Built Drawings shall include a minimum of three (3) ties to each manhole from fixed permanent objects. As-Built Drawings shall be stamped with the seal of a licensed land surveyor and licensed professional engineer.

2. Submit four (4) sets of 24-inch by 36-inch drawings and a digital copy in a CD format to the Engineer prior to obtaining certificate of Substantial Completion.

C. Inspections

1. The system shall be inspected when the following installation and milestones are happening: fill is placed and compacted; the pipe installation occurs; the bottom of trenches dug; manifold pipes installed; other piping is installed; the pumps and pump station are installed; septic tank(s) and grease trap are installed; treatment units installed (if required) leakage tests are performed; system clear water test is conducted and when final cover is placed.

2. The Contractor shall be responsible for the provisions and all test requirements as specified for gravity sewer pipe and for pressure rated sewer pipe.

3. Manufacturers certificates of compliance shall be furnished with the materials upon delivery to the project site.

4. Inspection of pipe and other items may be made by Engineer and subject to rejection at any time on account of failure to meet any of the Specification requirements, even though sample pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked and immediately removed from the site.

1.05 WARRANTY AND GUARANTEES

A. Contractor shall provide, in the name of the Owner, the following:

1. A one year warranty on labor, equipment and workmanship for installation of the complete sewerage pump station project.

B. Contractor shall obtain in the name of the Owner, a warranty from the manufacturer of the assembled sewage pump station for the manufacturer's labor and equipment for a minimum period of three (3) years.

C. Contractor shall obtain, in the name of the Owner, a standard warranty from the manufacturer of each piece of equipment supplied within the Subsurface Wastewater Disposal System, of which some are listed as follows:

1. Pumps and motor units.

2. Control panels.

3. Liquid level sensors.

4. Valves.

5. Treatment units.

6. Blowers.

7. Meters.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Care shall be taken in loading, transporting and unloading to the structures, pipe, valves, fittings, pumps, and other materials furnished under this section.

B. Store materials on the job site in accordance with manufacturer's recommendations.

PART 2 – PRODUCTS

2.01 POLYVINYL CHLORIDE PIPE (PVC) GRAVITY SEWER PIPE

A. Pipe and Fittings: Polyvinyl chloride pipe and fittings with integral wall bell and spigot joints for the conveyance of sewage from the terminus of cast iron building sewer to septic tank or grease trap and from septic tank to the pump chamber shall be SDR 35 polyvinyl chloride (PVC) gravity sewer pipe with full diameter dimensions conforming to the specifications for SDR gravity sewer pipe. The pipe shall be colored green for in ground identification as sewer pipe. The elastomeric gasket seal in push on joints shall conform to ASTM F477 or ASTM F913. The pipe shall conform to ASTM D1785 and ASTM D3034, latest issue. The gravity sewer pipe shall be a minimum 6-inch diameter.

B. Joints: PVC pipe push-on joint shall have elastomeric gaskets secured in placed in the bell of the pipe. The solid cross section elastomeric gasket shall be factory assembled, and securely locked in place to prevent displacement during assembly. Elastomeric gaskets shall conform to ASTM F477 or ASTM F913.

C. Fittings and accessories shall be manufactured and furnished by the pipe supplier and have bell and spigot configurations compatible with the pipe. The fittings and accessories shall conform to the same ratings as the pipe.

2.02 POLYVINYL CHLORIDE PIPE (PVC) SCHEDULE 40 PIPE (SCHEDULE 40)

A. Pipe and Fittings: Polyvinyl chloride pipe and fittings for non-perforated gravity distribution pipe and perforated gravity distribution pipes, (1/2 inch to 12 inches), and air distribution lines shall be ASTM D1785, Schedule 40 PVC.

B. Joints:

1. Pipe shall have solvent welded joints conforming to ASTM D2564.

2. The pipe, fittings, and joints shall hold 100 psi internal pressure.

2.03 POLYVINYL CHLORIDE PIPE (PVC) SCHEDULE 80 PIPE (SCHEDULE 80) FOR VENT PIPING AND DRAIN

A. Pipe and Fittings: Polyvinyl chloride pipe and fittings for piping shall be ASTM D1785, Schedule 80. Pipe used for vents shall be designed to function with snow cover and shall be as unobtrusive as possible.

B. Joints: Solvent welded joints with solvent cement conforming to ASTM D2564.

2.04 POLYVINYL CHLORIDE PIPE (PVC) PRESSURE PIPE (SDR 21)

A. Pipe and Fittings External to Structures: Polyvinyl chloride pipe and fittings for pressure systems (1-1/2 inch to 12 inches) shall be SDR21 PVC pressure pipe as described in ASTM D2241. The PVC material used shall be Type I, Grade I compound as stated in ASTM D1784. The pipe shall be push on joint bell and spigot type suitable for a rated pressure of 200 psi internal pressure.

B. Joints: Pipe joints shall have factory installed rubber rings conforming to ASTM F477 and a joint design tested to the requirements of ASTM D1339 for SDR 21 PVC pressure pipe.

C Install at locations and sizes indicated on Drawings.

2.05 DUCTILE IRON PIPE AND FITTINGS

A. Ductile iron pipe and fittings shall be installed where shown or indicated on the Drawings. The piping shall be designed and manufactured in accordance with ANSI A21.60/AWWA C106 AND ANSI A21.10 (AWWA C110) or ANSI B16.1 for flanges and flanged fittings.

B. Cast iron pipe shall be ANSI Pressure Class 350 furnished in suitable lengths to produce an operational system as shown on the plans.

C. The exterior of all pipe shall be factory coated, with a double coat of coal tar enamel conforming to ANSI A21.4/AWWA C104.

2.06 SLEEVES

A. All wall penetrations shall use cast sleeves for all piping entering or exiting structures.

B. Transition couplings for joining pipe of different diameters shall be Dresser Style 162, or approved equivalent. Couplings shall be installed with corrosion resistant nuts and bolts.

2.07 COUPLINGS AND CONNECTORS

A. Sleeve Type, Buried

B. Cast iron or epoxy coated steel, middle rings, ASTM A513.

2. Reducer type (where required).

3. Followers, two steel rings epoxy coated.

4. Bolts ANSI A21.11/AWWA C111, galvanized.

5. Two wedge section compressible gaskets.

6. Dresser Manufacturing Co., Style 38, 162, or 128 as appropriate

C. Sleeve Type, Exposed

1. Steele middle ring, shop prime.

2. Reducer type for different pipe sizes.

3. Two steel follower rings.

4. Two wedge section compressible gaskets.

5. Steel bolts.

6. Dresser Manufacturing Co., Style 38.

D. Flexible Connectors

1. Do not use rubber or elastomeric PVC type flexible couplings to connect pressure sewers.

2. Material shall be compatible with pipes being joined.

3. Maximum allowable deflection per joint shall be 15 degrees or per manufacturer's recommendation, whichever is less.

4. Stainless steel metal retaining rings.

5. Use suitable retaining control rods.

2.08 PLUG VALVES

A. Flanged Eccentric Plug Valves, Manually Operated.

1. Buna-N multiple "V" ring stem packing seals.

2. Bolted and sealed bonnet, O-ring seal.

3. Type 316 stainless steel permanently lubricated shaft bearings in upper and lower trunnions.

4. Cast iron body and cover, ASTM A126, Class B.

5. Flanges, ANSI B16.1, Class 125.

6. Welded and machined corrosion resistant nickel seat, 1/8 inch thick minimum.

7. Cast iron valve plug, ASTM A126, Class B coated with Buna-N rubber injection mold process on that portion within the body cavity.

8. Quarter turn, counterclockwise open, with position indicators at 10-degree increments.

9. Manufacturers: Clow Valve Company, Oskaloosa, IO; DeZurik, SPX Corporation, Charlotte, NC; or approved equal.

2.09 CHECK VALVES

A. Cast Iron Body Outside Lever and Weight

1. AWWA C508.

2. Stainless steel hinge pin.

3. Double bronze plug construction.

4. Flanges, ANSI B16.1, 125 lb.

5. Pressure rated: 150 psi seat, 400 psi body, non-shock working pressure 200 psi.

B. Use in horizontal position, only.

C. Manufacturers

1. Clow Valve Company, Oskaloosa, IO.

2.10 THRUST RESTRAINTS IN STRUCTURES

A. Thrust restraint clamps and pipe hangers/restraints shall be supplied and furnished as recommended by the pipe and fittings manufacturers.

B. Pipe restraints within precast below-ground structures shall be constructed of stainless steel.

2.11 THRUST RESTRAINTS AND THRUST BLOCKS (PIPING)

A. Thrust restraint clamps and pipe hanger/restraints shall be installed in accordance with the details shown on the Drawings and the recommendations of the pipe and fittings manufacturers.

B. Thrust blocks shall be installed at all changes in direction of the pressure piping system. The Contractor shall furnish and install the thrust blocks in accordance with the requirements and recommendations of the AWWA. Test pits may be required in areas of existing utilities to determine the exact location and dimensions of thrust restraints.

C. Concrete for thrust blocks shall a minimum 28 day compressive strength of 3,000 psi.

2.12 ALUMINUM HATCHES AND SAFETY GRATE

A. Hatch covers designed for HS-20 loading and 300 pounds per square foot with a maximum deflection of 1/150 of the span, Cover shall have a 1/4 inch thick diamond pattern.

B. The wet well hatch shall be provided with a hinged aluminum safety grate. Grate opening shall allow for visual inspection of the wet well and valve pit once the hatch is open. Grate shall provide a barrier between the operator and the pit. Grate design shall use safety factors as defined in the Aluminum Association (AA) 'Aluminum Design Manual' and ANSI/NAAMM MBG 531-00'Metal Bar Grating Manual'.

C. The valve chamber hatch shall be a standard aluminum hatch (no safety grate).

D. Frames shall be extruded aluminum with stop anchors.

E. Hinges shall be designed for horizontal installation and be through bolted with Type 316 stainless steel bolts and locknuts.

F. Provide continuous EPDM gasket and a drain coupling for the frame channel.

G. Standard hatch and hatch with safety grate shall be manufactured by one of the following or approved equal:

1. Bilco.

2. Babcock-Davis.

3. J.L. Industries.

2.13 PRECAST CONCRETE STRUCTURES

A. General Requirements

1. Concrete shall have a minimum compressive strength of 5,000 psi at 28 days. Precast sections shall be cured by an approved ASTM Method and shall not be shipped nor subject to loading after fabrication until the concrete compressive strength has attained the 5,000 psi design strength. The Portland cement shall be Type II, ASTM C150.

2. Precast structures shall be designed for the following loads and possible combinations thereof:

a. H-20 loading with and on the riser with frame and cones, plus the weight of the soil above.

b. Weight of precast concrete structure.

c. Uplift slab connections.

d. Initial handling and erection loading.

3. All reinforcement shall be deformed steel conforming to ASTM A615 Grade 60 and shall have a 1-1/2 inch minimum concrete cover.

4. All precast units joints, seals and openings, shall be watertight after assembly, and installation.

5. Pipe connections shall be flexible sleeve or rubber gaskets such as 'Lock Joint', 'Kor-n-Seal', 'A-Lok', '8QRS-PSX', or approved equal. Annulus between flexible connection and concrete shall not be grouted.

6. Riser sections shall be constructed of solid reinforced precast concrete.

7. Manhole frame and cover shall be gray iron casting conforming to ASTM A48, heavy duty, with 'Sewer' embossed in 2 inch letters on the cover.

2.14 SEWER MANHOLES

A. Precast Construction:

1. Structure: 48-inch diameter precast units (4,000 psi minimum compressive strength) with eccentric cone section tapering to 30-inch diameter and monolithic base section conforming to ASTM C478.

2. Precast Unit Joint: Butyl rubber section joint conforming to ASTM C443.

3. Steps: Steel reinforced copolymer polypropylene steps conforming ASTM C478.

4. Exterior: Bituminous coating.

5. Manhole Frame and Cover: East Jordan Iron Works 2008Z/2006A or approved equal with "Sewer" embossed in 2-inch letters on the cover.

B. Unit Masonry Construction:

1. Brick shall conform to ASTM C32 Grade MS or ASTM C62, Grade SW. Brick for construction of inverts and adjusting manholes to grade shall be ASTM C32, Grade SM.

2. Concrete block shall be solid block conforming to ASTM C139.

3. Mortar shall be a Portland cement mortar conforming to ASTM C270, Type M. The mortar shall be composed of Portland cement hydrated lime, and sand, in the proportions of 1 part cement to 1/4 part hydrated limit to 3-1/2 parts sand, by volume.

4. Cement shall be Type I or Type II Portland cement conforming to ASTM C150. Where masonry is exposed to salt water, Type II Portland cement shall be used.

5. Hydrated lime shall be Type S conforming to ASTM C207.

6. Sand for masonry mortar shall conform to the gradation requirements of ASTM C144.

2.15 GREASE TRAP

A. The grease trap shall be precast concrete multi-compartment tank. The minimum size as shown on the Drawings with two compartments of equal capacity.

B. Grease trap shall be furnished with inlet and outlet tees, in each compartment.

C. Double layer of butyl rubber sealant shall be used for all section joints.

D. A 30-inch diameter riser section shall be provided over each inlet tee and each outlet tee.

E. Manhole frame and cover shall be East Jordan Iron Works 2114Z/2110A, or approved equal with 'Sewer' embossed in 2-inch letters on the cover.

2.16 SEPTIC TANK

A. Precast concrete septic tank or tanks of the sizes shown on the Drawings shall be precast concrete, manufactured in accordance with the requirements of NYSDOH.

B. Septic tanks shall be furnished with inlet and outlet tees, gas baffles, and stainless steel supports.

C. Double layer of butyl rubber sealant shall be used for all section joints.

D. A 48-inch diameter riser sections shall be provided over each inlet tee and each outlet tee.

2.17 DISTRIBUTION BOXES (IF REQUIRED)

A. Distribution box shall be precast concrete with the required number of outlets.

B. Distribution box shall be furnished with outlet leveling devices as shown on the Drawings.

C. A riser section with frame and cover shall be provided as shown on the Drawings.

2.18 CAST-IN-PLACE CONCRETE ANTI-FLOTATION PAD

A. When groundwater is encountered during excavation, the Contractor shall report the groundwater elevation to the Engineer.

B. Buoyancy calculations shall be prepared by a licensed professional engineer for the following items: pump station, valve chamber. The calculations shall provide a factor of safety against floatation of 1.25. The following criteria shall be used in computing the buoyancy and anti-flotation solution for the above system items.

1. Assumptions:

   Concrete = 150 lb./ft.^{3}
   Water = 62.4 lb./ft.^{3}
   Minimum Factor of Safety = 1.25
   Empty Structure
   Overburden at 110 lb./ft.^{3}

B. Anti-flotation pad shall have dimensions suitable to resist buoyant forces associated with maximum groundwater elevation.

C. Concrete for anti-flotation pad shall have a minimum 28-day compressive strength equal to that of precast concrete structure to which it is attached.

D. Reinforcement shall be deformed steel conforming to ASTM A615 Grade 60 and shall have a 2 inch minimum concrete cover.

2.19 BITUMASTIC COATINGS

A. The entire exterior surface of all masonry and concrete (whether precast concrete or cast-in-place concrete) structures associated with sewerage systems, such as manholes, grease traps, holding tanks, tight tanks, septic tanks, aeration tanks, pump stations, valve pits, etc., shall receive two (2) coats of waterproofing such as Carboline Bitumastic 300M, manufactured by Carboline Company, St. Louis, MO 63144-1599; Sonoshield HLM 5000, manufactured by Degussa Building Systems, Shakopee, MN 55379; or approved equal applied at a minimum thickness of 7 mils per coat and a total thickness of 14 mils, however in no case shall the thickness per coat be less than that recommended by the manufacturer.

2.20 LIGHTING

A. Lighting shall be installed in wet well, valve chamber, and electrical control boxes as shown and in accordance with Section 260540 – ELECTRICAL (SITE).

2.21 CONTROL PANELS - FOR TREATMENT UNITS, PUMPS AND AUTOMATIC VALVES

A. The control panel shall be installed in the building at the location allocated for the pump station and treatment units. A remote alarm panel shall be located in a location acceptable to the Owner.

B. The control system shall have intrinsically safe relays to control the pumps, valves, and treatment units. The wire shall be sized to account for voltage drop.

C. The control system shall initiate starting and stopping of pump motors, automatic control of pumps, and provide automatic system control of all treatment process units and the effluent disposal system. Manual override and control of all functions shall be required.

D. Automatic Controls:

1. Provide liquid level controls in combination with a starter or panel.

2. Type: Mechanical float switches in unbreakable steel shell encased in solid polyurethane suitable for continuous immersion.

E. Electrical Control:

1. Provide an automatic pump control center in a NEMA 4X enclosure for voltage and phase indicated.

2. Provide the following for each motor:

a. Combination breaker/overload unit providing overload protection, short circuit protection, and a reset and disconnect for all phases.

b. Across-the-line magnetic starters.

c. Hand/off automatic pump operations selector switch.

d. Overload device, precalibrated to match motor characteristics and factory sealed to ensure trip setting is tamperproof and configured to shutting down the pump.

e. Control pilot circuitry: 120 volt.

f. Moisture sensor and test switch capable of stopping pump upon activation of alarm.

3. Provide one (1) control circuit transformer for external pilot circuitry for each treatment unit and provide alternating operation of pumps under normal conditions.

4. Provide terminal boards for connection of line, pump, and level sensors.

5. Provide alarm indicator lights on inner control panel door.

6. Provide external electrical control module alarm light to indicate unit malfunction conditions.

PART 3 – EXECUTION

3.01 GENERAL

A. The Contractor shall construct the subsurface disposal system in conformance with the latest revision of local or state regulations, whichever is more stringent.

B. The type of materials to be used in work and the method of placement shall conform to the requirements of Section 310000 - EARTHWORK .

3.02 PIPE INSTALLATION

A. Laying Pipe: Each length of pipe shall be laid with firm, full and even bearing throughout its entire length. Pipe will be laid with bell upgrade unless otherwise approved by the Engineer.

1. Every length of pipe shall be inspected and cleaned of all dirt and debris before being laid. The interior of the pipe and the jointing seal shall be free from sand, dirt, and trash before installation. Extreme care shall be taken to keep the bells of the pipe free from dirt and rocks such that joints may be properly assembled without overstressing the bells. No pipe shall be trimmed or chipped to fit.

2. No length of pipe shall be laid until the preceding lengths of pipe has been thoroughly embedded in place, to prevent movement or disturbance of the pipe.

B. Full Lengths of Pipe: Only full lengths of pipe shall be used, except that partial lengths of pipe may be used at the entrance to structures where required for the connection to the structure.

C. Pipe Entrances to Structures: All pipe entering structures shall be cut flush to allow fittings to be set inside the structure. The cut ends of the pipe surface within the structure shall be rounded and finished so there will be no ragged edges or imperfections that will impede the flow of water or affect the hydraulic characteristics of the installation. The method of cutting and finishing shall be in accordance with manufacturer's instructions.

D. Protection During Construction: At all times when pipe laying is not in progress, all open ends of pipes shall be closed by approved temporary water-tight plugs. If water is in the trench when work is resumed, the plug shall not be removed until the trench has been dewatered and all danger of water entering the pipe eliminated.

3.03 PIPE JOINTS

A. All joints shall be watertight.

B. Pipe shall be jointed in strict accordance with the pipe manufacturer's instruction. Jointing of all pipe shall be done entirely in the trench.

1. Lubricant for jointing of bell and spigot PVC pipe shall be applied as specified by the pipe manufacturer. Use only lubricant supplied by the pipe manufacturer.

2. Bell and spigot pipe shall be pushed home by hand or use of bar and block. The use of power equipment, such as a backhoe bucket, is not recommended and shall not be used.

3. Field-cut pipe shall be cut square. The cut end of the pipe surface shall be properly beveled to the size and shape of a factory-finished beveled end. All sharp edges shall be rounded off.

3.04 SOLVENT WELDED PIPE JOINTS (SCHEDULE 40 AND SCHEDULE 80 PVC)

A. Where solvent welded joints are used, a coating of primer shall be applied to the entire interior surface of the fitting socket and to an equivalent area of the exterior of the pipe end, prior to applying solvent cement. Primer and cement shall be applied with an appropriately sized applicator. The solvent cement shall be applied in strict accordance with the manufacturer's specifications. No primer or solvent cement material shall be deposited or extruded into the interior surface of the pipes during joining. The coated surfaces shall be immediately pushed together and rotated one quarter (1/4) turn to ensure uniform cement distribution. Excess cement on the exterior of the pipe shall be wiped clean immediately after assembly. Pipe shall not be primed or solvent welded during rain or when air temperature is below 40 degrees F., or above 90 degrees F., or in direct sun exposure. After solvent welding, the pipe shall remain undisturbed until cement has thoroughly set. Follow manufacturer's guidelines for solvent weld cure times.

B. Before any joint is made, the previously installed pipe shall be checked to ensure that a close joint with the adjoining pipe has been maintained and that the inverts are matched and conform to the required grade. The pipe shall not be driven down to the required grade by striking it with a shovel, timber, or other object.

C. Joints shall not be pulled, clamped, or crimped.

D. Where any two pipe sections do not fit each other closely enough to enable them to be properly joined, they shall be removed and replaced with suitable sections to allow a proper joint.

3.05 FLANGED PIPE JOINTS

A. All joints shall be watertight. Flanged joints shall be used inside structures.

B. Pipe shall be jointed in strict accordance with the pipe manufacturer's instructions.

1. The pipe and fittings shall have identical face to face and center to face dimensions, and the same flange drilling as ANSI B16.1 fittings.

2. The joints shall be made with full face gaskets.

3. The piping assemblies shall be secured with restraints and supports to remain in place.

3.06 THRUST BLOCKS

A. Thrust blocks shall be provided at all fittings and changes in direction of force mains. Thrust blocks shall provide firm bearing against undisturbed earth.

3.07 PRECAST MANHOLES AND TANKS

A. General Requirements: Structures shall be constructed and pipe systems installed between structures for accurate alignment of pipe.

B. The Contractor shall accurately locate each structure and set accurate templates to conform to the required line and grade. Any structure that is mislocated or oriented improperly shall be removed and rebuilt in its proper location, alignment, and orientation.

C. Foundation: Structures shall be constructed on a 12-inch layer of compacted bedding material. The excavation shall be dewatered while placing bedding material and setting the base.

D. Frames, Covers, Hatches, and Gratings: Access devices for structures shall be well placed and set accurately to the correct alignment and grade. Access hatches shall be set in top slab of chambers as shown on Drawings.

E. Bitumastic Coating: The entire exterior surface of all subsurface structures shall be coated with two (2) coats of an approved bitumastic material to produce a dry film thickness of 0.07 inches (7 mils) per coat.

F. Mortar plug all lifting holes in precast structures prior to backfilling.

3.08 MANHOLE AND TANK CONNECTIONS

A. Manhole Connections: Manhole pipe connections to precast manhole bases may be accomplished by any method described below. The outside diameter of the pipe shall be compatible with the particular pipe connection used.

B. Tank Connections: A watertight flexible connection shall be installed for the pipe to connection to manholes, septic tanks, dosing/pump chamber, and valve chamber, using one of the below listed connections.

C. Connections Types / Products:

1. The ‘Lock Joint Flexible Manhole Sleeve’ cast in the wall of the structure. The stainless steel strap and exposed sleeve shall be protected from corrosion with a bitumastic coating.

2. ‘Press Wedge II’ gasket cast in the wall of the structure. The rubber wedge shall only be driven into the V slot from the outside of the structure.

3. The ‘RES-SEAL’, a cast iron compression ring which compresses a rubber "O" ring gasket into a tapered hole in the wall of the structure. Exposed metal shall be protected from corrosion with a bitumastic coating.

4. ‘KOR-N-SEAL’ joint which has a neoprene boot cast into the structure wall shall be installed as recommended by the manufacturer. The stainless steel clamp shall be protected from corrosions with a bitumastic coating.

3.09 PRECAST CONCRETE TANK INSTALLATIONS (SEPTIC TANK, GREASE TRAP, AND OTHERS)

A. Foundation: Precast concrete tanks shall be constructed on a 12 inch layer of compacted crushed stone material. The excavation shall be dewatered while placing material and setting the base.

B. Frames, Covers, Access Hatches: Frames shall be well bedded in mortar and shall be set accurately to correct alignment and grade.

C. Grade Adjustment: Frame and Cover Riser sections shall be set sufficiently below finished grade to permit a maximum of five (5) and a minimum of two (2) courses of brick to be used as risers to adjust the grade of the casting. Manhole frames shall be set on a grout pad to make a watertight fit.

D. Tank Assembly: Each tank section shall be lowered into place or pulled together on the sealing material, positioned and leveled before the next section is installed. All joint surfaces shall be clean prior to placing sealer and gasket, and prior to assembly of subsequent sections.

E. Each joint shall be made watertight and sealed with the manufacturer's recommended seal and gasket.

3.10 LEACHING SYSTEM INSTALLATION

A. Topsoil, subsoil, peat, and other impervious materials shall be removed from all areas beneath the leaching facility for a distance of five feet (5 ft.) beyond the soil adsorption area in all directions and replaced with clean, coarse washed sand. The washed sand shall have a percolation rate of less than two minutes per inch, after compaction to 93% of maximum dry density (ASTM D1557). Sand fill shall be placed on a raked original soil interface with step terraces that 'key' the soil if required due to a side hill condition.

B. Excavation may be made by machinery provided that the soil at the bottom of the soil adsorption area is not compacted or 'smeared'. The bottom of each excavation shall be level. No leaching system construction shall proceed in frozen soil or in wet weather.

C. Storm water runoff shall not be allowed to pass over the leaching system area or reserve area at any time during construction.

D. Manifolds shall be installed at the required locations and elevations and shall be installed on a compacted, level foundation of gravel at least 12-inches thick. Gravel shall be as specified in Section 310000 - EARTHWORK.

E. Sand material for on site disposal system leaching area shall be placed and compacted as specified in Section 310000 - EARTHWORK to the limits shown on the Drawings and kept free from contamination by fine soil particles at all times.

F. All pipe shall be sound and clean before laying. When laying is not in progress, the open ends of the pipe shall be closed by watertight plug or other approved means. Alignment shall be preserved in laying the pipe in accord with the system designs. The deflection at joints shall not exceed that recommended by the pipe manufacturer. A firm, even bearing throughout the length of the pipe shall be constructed by hand tamping granular

material at the sides of the pipe and in accordance with pipe manufacturer's recommendations.

G. Before any joint is made, the previously installed pipe shall be checked to ensure that a close joint with the adjoining pipe has been maintained and that the inverts are matched and conform to the required grade. The pipe shall not be driven down to the required grade by striking it with a shovel, timber, or other object.

H. Joints shall not be pulled, clamped, or crimped.

I. Where any two pipes do not fit each other closely enough to enable them to be properly jointed, they shall be removed and replaced with suitable pipes.

J. Pressure distribution laterals shall be level.

K. Any defective material discovered after it has been laid shall be removed and replaced.

L. The soil adsorption system shall be constructed to conform to regulations. The 3/4-inch to 1-1/2 inch 'triple washed crushed stone for wastewater soil adsorption systems' ('Septic Stone') shall extend the full width and depth of the trench or bed, shall extend 12 inches minimum below the invert elevation of the perforated pipe and extend to the crown of the pipes. The 1-1/2 inch washed 'septic stone' shall be covered with at least a 2-inch layer of 1/8 inch to 1/2 inch washed peastone. The stone surface shall be covered by a filter fabric, such as Mirafi 140N as manufactured by Mirafi, Inc., Charlotte, NC 28224, or approved equal. The soil adsorption area shall be kept free from contamination by fine soil particles at all times. Stone shall be double washed crushed stone for wastewater soil adsorption system and then shall be 'triple' washed'. This means that the stone receives a final wash in the transport container (truck body). The stone in the container shall be washed until the runoff water runs clear, and the stone is clean and free of silt or clay particles.

M. Fill materials used to cover soil adsorption area shall be free of large stones, frozen clumps of earth, masonry, stumps or waste construction materials. Machinery that may crush or disturb the alignment of pipe in the disposal system shall not be allowed on any part of the disposal area.

N. Filter fabric shall be placed over the soil adsorption area as shown on the Drawings.

3.11 LEAKAGE TESTS FOR PIPING AND STRUCTURES

A. General Requirements: The Contractor shall test the completed gravity sewers force mains, non-perforated distribution lines and structures, for leakage by infiltration, exfiltration or low-pressure air exfiltration tests.

1. The Contractor shall furnish and install all necessary equipment, materials and labor for performing the tests.

2. The Contractor shall notify the Engineer at least 48 hours prior to the start of testing. Testing shall only be performed in the presence of the Engineer.

3. Sections of pipe tested for infiltration and exfiltration prior to completion of the Contract shall be subject to additional leakage tests, if warranted in the opinion of the Engineer prior to acceptance of the Work.

B. Infiltration and Exfiltration Testing: The test length intervals for either type of leakage test shall be approved by the Engineer, but in no event shall they exceed one thousand feet (1,000 ft.). In the case of sewers laid on steep grades, the length of line to be tested by exfiltration at any one time shall be limited by the maximum allowable internal pressure on the pipe and joints at the lower end of the line. The maximum internal pressure at the lowest end should not exceed 25 feet of water or 10.8 psi.

1. The test period, wherein the measurements are taken shall not be less than four (4) hours in either type of test.

2. Depending on field conditions, the following tests for leakage shall be employed:

a. Infiltration Test: The test may be used only when ground water levels are at least five feet (5 ft.) above the top of the pipe for the entire length of the section to be tested during the entire period of the test. Ground water levels may be measured in an open trench or in standpipes previously placed in backfilled trenches during the backfilling operations. When standpipes are installed in the backfill for ground water measurement, the lower ends of these shall be satisfactorily embedded in a mass of crushed stone or gravel to maintain free percolation and drainage. Infiltration through joints shall be measured by using a watertight weir or any other approved device for volumetric measurement installed at the lower end of the section under test.

b. Exfiltration Test: This test consists of filling the pipe with water to provide a head of at least five feet (5 ft.) above the top of the pipe or five feet above ground water, whichever is higher, at the highest point of the pipe line under test, and then measuring the loss of water from the line by the amount which must be added to maintain the original level. In this test the line must remain filled with water for at least twenty-four hours prior to the taking of measurements. Exfiltration shall be measured by the drop of water level in a closed-end standpipe or in one of the sewer manholes available for convenient measuring.

1). When a standpipe and plug arrangement is used in the upper manhole of a line under, test positive method of releasing entrapped air in the sewer prior to taking measurements.

c. Leakage Requirements: The total leakage of any section tested shall not exceed the rate of 50 gallons per day per mile per inch of nominal pipe diameter. For purposes of determining the maximum allowable leakage, manholes shall be considered as sections of 48-inch diameter pipe, five feet (5 ft.) long, and the equivalent leakage allowance shall be 2.25 gallons per manhole per 24 hours.

C. Low-Pressure Air Exfiltration Testing

1. The sewer system shall be tested for leakage by the use of low-pressure air as specified hereinafter and as approved by the Engineer. The test length shall not exceed one interval of pipe between two manholes. Air test procedures may be dangerous and the Contractor shall take all necessary precautions to prevent blowouts.

2. Plugs shall be as follows:

a. Pneumatic plugs shall have a sealing length equal to or greater than the diameter of the pipe to be tested.

b. Pneumatic plugs shall resist internal test pressures without requiring external bracing or blocking.

c. All air used shall pass through a single control panel.

d. Three individual hoses shall be used for the following connections:

1). from control panel to pneumatic plugs for inflation;

2). from control panel to sealed line for introducing the low pressure air;

3). from sealed line to control panel for continually monitoring the air pressure rise in the sealed line.

3. The following testing procedures shall be explicitly followed:

a. All pneumatic plugs shall be seal tested before being used in the actual test installation. One length of pipe shall be laid on the ground and sealed at both ends with the pneumatic plugs to be checked. Air shall be introduced into the plugs to 25 psi. The sealed pipe shall be pressurized to 5 psi. The plugs shall hold against this pressure without bracing and without movement of the plugs out of the pipe.

b. After the pipe has been backfilled and cleaned, pneumatic plugs shall be placed in the line at each manhole and inflated to 25 psi. Low-pressure air shall be introduced into this sealed line until the internal air pressure reaches 4 psi greater than the average back pressure of any ground water that may be over the pipe. At least two minutes shall be allowed for the air pressure to stabilize.

c. After the stabilization period (3.5 psi minimum pressure in the pipe), the portion of line tested shall be acceptable if the time required in minutes for the pressure to decrease from 3.5 psi to 3.0 psi (greater than the average back pressure of any ground water that may be over the pipe) is not less than the time indicated in the following table:

Pipe Size (in.)	Time (sec.)
4	0.190L
6	0.427L
8	0.760L
10	1.187L
12	1.709L
15	2.671 L

Where L = length of pipe being tested

d. Correction of Defective Work: If leakage exceeds the specified amount, the Contractor shall at his own expense make the necessary repairs or replacements required to permanently reduce the leakage to within the specified limit, and the tests shall be repeated until the acceptable leakage requirement is met.

1). Any defects found in the system shall be repaired to conform strictly to the Specifications. All repairs shown necessary by the tests are to be made, and broken or cracked pipe replaced.

e. Compliance with Agency Requirements: In the event of conflict between the leakage test requirements specified herein with the leakage test requirements of agencies having jurisdiction over all or any portion of the sewer system installed under this Contract, the more restrictive requirements shall govern.

3.12 TESTING PRESSURE SEWER PIPE

A. Except as otherwise directed, all pressure sewers shall be given combined pressure and leakage tests in sections of approved length. The Contractor shall furnish and install suitable temporary testing plugs or caps; all necessary pressure pumps, pipe connections, meters, gates, and other necessary equipment; and all labor required. The Engineer may use his/her own gages or calibrate the Contractor's gages.

B. Subject to approval, and provided that the tests are made within a reasonable time considering the progress of the work as a whole, and the need to put the section into service, the Contractor may make the tests when desired. Pipelines in excavation or embedded in concrete shall be tested after the backfilling of the excavation or curing of the concrete and exposed piping shall be tested prior to field painting.

C. The section of pipe to be tested shall be filled with water of approved quality, and all air shall be expelled from the pipe. If blowoffs are not available at high points for releasing air, the Contractor shall install taps required at such points and shall plug the tap holes after completion of the test.

D. The section under test shall be maintained full of water for a period of 24 hours prior to the combined pressure and leakage test being applied.

E. The pressure and leakage test shall consist of first raising the water pressure (based on the elevation of the lowest point of the section under test corrected to the gage location) to the pressure rating of the pipe. If the specified pressure cannot be achieved and maintained for a period of one hour, the section shall be considered as having failed to pass the test.

F. Following or during the pressure test, the Contractor shall make a leakage test by metering the flow of water into the pipe while maintaining a pressure equal to the pressure rating of the pipe. If the average leakage during the two-hour period exceeds a rate of leakage indicated in AWWA C600 per 24 hours per mile of pipeline, the section shall be considered as having failed the leakage test.

G. If the section fails to pass the pressure and leakage test, the Contractor shall locate, uncover, and repair or replace the defective pipe, fitting, or joint all. Additional tests and repairs shall be made until the section passes the specified test.

H. If, in the judgment of the Engineer, it is impracticable to follow the foregoing procedure exactly for any reason, modifications in the procedure will be made as required and approved, but in any event the Contractor shall be responsible for the ultimate tightness of the line within the above leakage and pressure requirements. Passing the test does not absolve the Contractor from responsibility if leaks develop later within the period of warranty.

I. The pressure distribution laterals shall be tested by running the pumps to assure water distribution and 2.5 feet of head, at the test manometers installed at the end of the lateral dosing pipes.

3.13 TESTING SEPTIC TANKS, GREASE TRAPS, AND MANHOLES

A. The installed structures shall be tested for liquid level, inlet and outlet function, seal integrity, and structure integrity. Except as otherwise directed, all structures and appurtenances shall be given combined pressure and leakage tests. The Contractor shall furnish and install suitable temporary testing plugs or caps; all required pressure pumps, pipe connections, meters, gates, and other necessary equipment. The Engineer may use his/her own gages or calibrate the Contractor’s gages.

B. The tanks under test shall be maintained full of water for a period of 24 hours prior to the combined pressure and leakage test being applied.

C. The pressure and leakage test shall consist of first raising the water pressure (based on the elevation of the lowest point of the structure under test corrected to the gage location) to a pressure of 5 psi. If the Contractor cannot achieve the specified pressure and maintain it for a period of one hour, the structure shall be considered as having failed to pass the test.

D. Following or during the pressure test, the Contractor shall make a leakage test by metering the flow of water into or out of structure while maintaining test pressure. If the average leakage during the two hour period exceeds a rate of leakage of 0.1 gallons per foot of depth, the structure shall be considered as having failed the leakage test.

E. If the structure fails to pass the pressure and leakage test, the Contractor shall do everything necessary to locate, uncover, and repair or replace the defective area, fitting, or joint, all at his own expense and without extension of time for completion of the work. Additional tests and repairs shall be made until the structure passes the specified test.

F. If, in the judgment of the Engineer, it is impracticable to follow the foregoing procedure exactly for any reason, modifications in the procedure shall be made as required and approved, but in any event the Contractor shall be responsible for the ultimate tightness of the structures within the above leakage and pressure requirements. Passing the test does not absolve the Contractor from his responsibility if leaks develop later within the period of warranty.

3.14 PUMP INSPECTION AND TESTS

A. Inspection and Tests: The pump manufacturer shall also perform the following inspections and tests on each pump before shipment from factory.

1. Impeller, motor rating and electrical connections shall be checked for compliance to the customer's purchase order and the specifications.

2. A motor and cable insulation test for moisture content or insulation defects.

3. Prior to submergence, the pump shall be run dry to establish correct rotation and mechanical integrity.

4. The pump shall be run for 30 minutes submerged a minimum of six feet (6 ft.) under water.

5. After Operational Test No. 4, the Insulation Test (No. 2) shall be performed again.

6. A written report stating the foregoing has been done shall be supplied with each pump at the time of shipment.

7. The pump cable end will then be fitted with a shrink fit rubber boot to protect it prior to electrical installation.

B. Preliminary Field Test: As soon as conditions permit, the Contractor shall furnish all labor, materials, and instruments, and shall make preliminary field tests of equipment. If the preliminary field tests disclose that any equipment furnished under this Contract does not comply with the requirements of the Contract Documents, the Contractor shall, prior to the acceptance tests, make all changes, adjustments, and replacements required.

C. Final Field Tests: Upon completion of the work and prior to acceptance and final payment, all equipment and appliances shall be subjected to tests for compliance with the Contract Documents. The Contractor shall furnish labor, fuel, lubricants, energy, water, and all materials, equipment, and instruments necessary for all acceptance tests.

D. Failure of Tests: Any defects in the equipment, failure to meet guarantees or requirements of the Specifications, shall be promptly corrected by the Contractor by the replacement or other means as required. The decision of the Engineer as to whether or not the Contractor fulfilled the obligations under the Contract, or Contractor fails to make these corrections or if the improved equipment when tested shall fail again to meet the guarantees or specified requirements, the Owner, may reject said equipment and order the Contractor to remove it from the site.

E. Responsibility During Tests: The Contractor shall be fully responsible for the proper operation of equipment during tests and instruction periods and shall neither have nor make any claim for damage which may occur to equipment prior to the time when the Owner formally accepts the equipment.

F. Tools, Accessories, and Spare Parts: The Contractor shall furnish with each type, kind, or size of equipment any special suitably marked high-grade tools and appliances which may be required to adjust, operate maintain, or repair the equipment. Such tools and appliances shall be properly labeled and delivered to prior to the initial operation of the equipment.

G. Manufacturer's Services

1. The Contractor shall arrange for the service of an authorized manufacturer's representative to assist the Contractor, when required, to install, adjust, and test the equipment. When the equipment is placed in permanent operation, the representative shall be on hand to make all adjustments and tests necessary or required to ensure that such equipment is in proper and satisfactory operating condition.

2. The manufacturer's representative shall instruct the Owner and Tenant's operating personnel in the operation and maintenance of the equipment. Two (2) copies of written reports by the representative covering inspection, testing, and instruction shall be sent directly to Engineer. An additional copy shall be sent to the Contractor.

3. The Contractor shall include in his Contract Price the services of the manufacturer's representatives for a minimum of one (1) day supervision of initial operation and operator instruction for each of the equipment items.

5. After Operational Test No. 4, the Insulation Test (No. 2) is to be performed again.

6. A written report stating the foregoing has been done shall be supplied with each treatment unit at the time of shipment.

7. The pump cable end shall be fitted with a shrink fit rubber boot to protect it prior to electrical installation.

3.15 CLEANING AND REPAIR

A. The Contractor shall clean the entire sewer system of all debris and obstructions. Cleaning shall include the removal of all formwork from structures, concrete and mortar droppings, and construction debris and dirt. The system shall be thoroughly flushed clean. No debris shall be flushed into existing sewers, drainage systems, and streams.

3.16 FINAL INSPECTION

A. Upon completion of the work and before final acceptance by the Engineer, the entire sewer system shall be subjected to a final inspection in the presence of the Owner and the Engineer. The work shall not be considered as complete until all requirements for line, grade, cleanliness, leakage tests, treatment unit clear water testing, and workmanship have been met.

3.17 GUARANTEE PERIOD

A. The equipment suppliers and the Contractor shall provide a written guarantee to the Owner warranting the operation and performance of the equipment for a period of three

(3) years from the date of acceptance. The equipment shall be repaired, replaced or supplemented should the equipment fail to perform and meet the guaranteed effluent discharge criteria.

3.18 FINAL INSPECTION

A. Upon completion of the Work and before final acceptance by the Owner, the wastewater disposal system and its related components shall be subjected to a final inspection in the presence of the Engineer.

B. A final clear water test shall include clear water operation of the pump station, treatment units, and other equipment for a period necessary to insure pumps, alarms, controls, emergency power system and auto-dialer operations function properly.

C. The Work shall not be considered as complete until all requirements for line, grade, cleanliness, leakage tests, treatment unit clear water testing, and workmanship have been met.

D. 'As Built Documents' shall be supplied to the Owner and Engineer prior to the final clear water test.

END OF SECTION 334723

SECTION 413423

PAINT SPRAY BOOTHS

PART 1 GENERAL

A. general requirements

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

section includes

C. Work of this Section includes all labor, materials, equipment, and services necessary to complete the paint booth(s) as indicated on the drawings and/or specified herein, including, but not limited to, the following:

Manufactured field assembled metal paint spray booth(s) including all components to provide a complete and operable system.

Air Makeup Unit(s) (AMU)

Paint Booth lights

Exhaust Fan(s)

Filter(s)

Accessories

related sections

D. Fire Suppression – Division 21.

E. Heating ventilating and air conditioning - Division 23.

F. Electrical - Division 26.

REFERENCES

A.

B. National Fire Protection Agency (NFPA) 33 – Standard for Spray Application Using Flammable or Combustible Materials

C.

D. National Fire Protection Agency (NFPA) 33 – Standard for Ovens and Furnaces

International Building Code (IBC)
International Fire Code (IBC)

National Electric Code (NEC)

Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations (CFR) 1910 – General Industry Standards

CONSUMER PRODUCT SAFETY COMMISSION (CPSC) 16 CFR 1201 - SAFETY STANDARD FOR ARCHITECTURAL GLAZING MATERIALS

American Society for Testing and Materials (ASTM) A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A527 - Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock-Forming Quality (Withdrawn 1994)
ASTM C-1036 - Standard Specification for Flat Glass
ASTM C1098 - Standard Specification for Nuclear-Grade Hafnium Oxide Powder
ASTM C834 - Standard Specification for Latex Sealants

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI) - STANDARD Z97.1 SAFETY GLAZING MATERIALS USED IN BUILDINGS

The National Electrical Manufacturers Association (NEMA) – Standard MG 1 *Motors and Generators*
NEMA -Standard 250 Enclosures for Electrical Equipment (1000 Volts Maximum)

SUBMITTALS

Submit under provisions of Section 013000 - Administrative Requirements.

Product Data: Manufacturer's data sheets on each product to be used, including:

1.1 Design Data, Test Reports: Provide manufacturer test reports indicating product compliance with requirements.
1.2 Preparation instructions and recommendations.
1.3 Storage and handling requirements and recommendations.
1.4 Installation methods.

Shop Drawings: Submit detailed drawings including, but not limited to, layout and dimension of panels, location and type of fasteners, method of attachment of all trim, location and types of sealants and installation sequence.

QUALITY ASSURANCE

Manufacturer Qualifications: Manufacturer shall have a minimum of five (5) years experience in the production of paint spray booths.

Installer Qualifications: The work shall be supervised by a person having a minimum of five (5) years experience installing paint spray booths on similar type and size projects.

WARRANTY

ALL MATERIALS AND LABOR WILL BE COVERED BY A ONE YEAR WARRANTY. MATERIALS OR LABOR FOUND DEFECTIVE WILL BE REPLACED AND/OR REPAIRED AT NO COST TO THE OWNER. THE CONTRACTOR IS THE SOLE REMEDY OF EQUIPMENT WARRANTIES.

PART 2 PRODUCTS

MANUFACTURERS

1. STANDARD TOOLS AND EQUIPMENT CO.

2. OR EQUAL

PAINT SPRAY BOOTHS

BASIS OF DESIGN: STANDARD TOOLS AND EQUIPMENT SEMI DOWNDRAFT PAINT BOOTH – 50'

STANDARD TOOLS AND EQUIPMENT CO. 4810 CLOVER ROAD, GREENSBORO, NC 27405, (888) 312-7488 WWW.PAINTBOOTHS.COM

OR EQUAL: SUBMIT WRITTEN REQUEST FOR OR EQUAL PRODUCT TO THE ARCHITECT. INCLUDE THE FOLLOWING INFORMATION:

MANUFACTURER AND MODEL

DRAWINGS, CUT SHEETS, PERFORMANCE AND TEST DATA

EQUIPMENT AND MATERIAL DATA

NFPA, OHSA AND IFC COMPLIANCE DATA

OTHER INFORMATION NECESSARY FOR EVALUATION

MATERIAL: 18 GAGE GALVANIZED STEEL

PAINT: POWDER COAT – WHITE (INTERIOR)

STEEL: MEETS ASTM 653

GALVANIZING: G90 @ 1.25 OZ. PER SQUARE FOOT, MEETS ASTM A527

WINDOWS: FULLY TEMPERED SAFETY GLASS

THICKNESS: 0.25"

STANDARDS: ANSI Z97.1, 16 CFR 1201, ASTM C1036, ASTM C1098

SEAL: CAULK TO ENSURE VAPOR PROOF SEAL

CAULK: DAP, INC. OR EQUAL

MEETS ASTM C834

EXHAUST FAN

TYPE: TUBEAXIAL

BLADE: NON-SPARKING

DRIVE: BELT IN MOTOR DUCT

APPROVAL: AMCA

FAN MOTOR

NEMA: A AND B

RATING: CLASS 2 DIVISION II

FAN MOTOR NOT TO BE LOCATED WITHIN 36" OF THE PAINT BOOTH OPENING

LISTINGS: UL/CSA

LIGHTS

TYPE: LED

INSIDE ACCESS LIGHTS: CLASS I DIVISION II

OUTSIDE ACCESS: SEPARATE BY 0.25" TEMPERED GLASS. SEAL WITH CAULK TO PROVIDE A VAPOR PROOF SEAL.

BLADE: NON-SPARKING

DRIVE: BELT IN MOTOR DUCT

APPROVAL: AMCA

FILTERS

INTAKE FILTERS:

MANUFACTURER: CHEMCO MFG. CO OR EQUAL

EFFICIENCY: 92.4%

UL CLASS II

EXHAUST FILTERS:

MANUFACTURER: CHEMCO MFG. CO OR EQUAL

ARRESTANCE EFFICIENCY: 98.66%

HOLDING CAPACITY: 0.41 LBS/FT^2

UL CLASS II

AIR MAKEUP UNITS (AMU)

MANUFACTURER: STANDARD TOOLS AND EQUIPMENT OR EQUAL

MODEL: SURE-CURE

LISTING: ETL TO ANSI Z83.4 AND CSA 3.7B

ALL CONTROLS AND MAJOR COMPONENTS UL AND/OR CSA LISTED

PROVIDE COMPLETE SYSTEM COMPLAINT WITH NFPA 33 AND NFPA 86

PROVIDE A HIGH TEMPERATURE LIMIT SWITCH TO AUTOMATICALLY SHUT OF DRY/CURE CYCLE IF THE TEMPERATURE IN THE SPRAY AREA EXCEEDS 200 F

PROVIDE INTERLOCK SO SPRAYING APPARATUS CANNOT BE OPERATED WHEN DRY/CURE CYCLE IS IN OPERATION

PROVIDE INTERLOCK TO SHUT DOWN DRY/CURE CYCLE IS IN OPERATION

RECIRCULATED AIR IS NOT PERMITTED

ANY RADIANT DRYING APPARATUS LOCATED IN THE SPRAY AREA SHALL BE LISTED FOR EXPOSURE TO FLAMMABLE OR COMBUSTIBLE VAPORS, MISTS, DUSTS, RESIDUES OR DEPOSITS

ACCESSORIES

MANOMETER: DWYER INSTRUMENTS MARK II MODEL 25 OR EQUAL

CONTROL PANEL: ETL LISTED

SOLENOID VALVES: ASCO REDHAT #8210G002 OR EQUAL

PROVIDE 4"X12" NO SMOKING DECALS AT ALL ENTRY POINTS TO THE PAINT BOOTH

PART 3 EXECUTION

EXAMINATION

THE CONTRACTOR SHALL ACQUAINT HIMSELF WITH THE FIELD CONDITIONS AND THE OTHER DIVISIONS OF WORK INCLUDED IN THIS PROJECT SO THAT HE MAY BE COMPLETELY FAMILIAR WITH ALL CONDITIONS PERTINENT TO THE FULFILLMENT OF THE WORK REQUIRED UNDER THIS SECTION.

INSPECT ALL RECEIVED ITEMS TO IDENTIFY MISSING, DAMAGED OR DEFECTIVE ITEMS.; NOTIFY MANUFACTURER OF ANY DEFECTS. DO NOT INSTALL DEFECTIVE COMPONENTS.

INSTALLATION

INSTALLATION SHALL BE IN ACCORDANCE WITH MANUFACTURER'S INSTALLATION GUIDELINES AND RECOMMENDATIONS.

INSTALL PAINT BOOTH PLUMB, LEVEL, AND TRUE-TO-LINE TO DIMENSIONS AND LAYOUT INDICATED ON APPROVED SHOP DRAWINGS.

ORIENT FAN/MOTOR, LIGHTS AND ALL OTHER COMPONENTS SUCH THAT THERE IS SUFFICIENT ACCESS FOR MAINTENANCE

DO NOT LOCATE ANY ELECTRICAL CONSTRUCTION WITHIN 36" OF ANY BOOTH OPENING UNLESS IT IS CLASS I DIVISION I RATED.

INSTALL NO SMOKING DECALS AT ALL ENTRY POINTS TO THE PAINT BOOTH. INSTALL ANY OTHER MARKINGS AS REQUIRED BY NFPA 33, NFPA 86, OSHA OR IFC AS REQUIRED.

AIR MAKEUP UNIT TO BE INSTALLED TO BE COMPLIANT WITH THE LATEST VERSIONS OF NFPA 33 AND NFPA 86

WORK PERFORMED BY OTHERS

THE FOLLOWING RELATED WORK WILL BE PERFORMED BY OTHERS. INSTALLER TO COORDINATE WITH THE RELATED TRADES.

ELECTRICAL POWER WIRING; BY EC

FIRE PROTECTION: BY FPC

SPRAY EQUIPMENT: BY OTHERS