ALTERATIONS TO SCHOOL DISTRICT FACILITIES-PHASE TWO
PEEKSKILL CITY SCHOOL DISTRICT

APN 1901.2

VOLUME 2 OF 2

SED CONTROL NO:

PEEKSKILL HIGH SCHOOL	66-15-00-01-0-010-022
HILLCREST ELEMENTARY	66-15-00-01-0-004-016
URIAH HILL ELEMENTARY	66-15-00-01-0-007-015

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Mosaic Associates Architects

Main Office - The Frear Building, 2 Third Street, Suite 440, Troy, New York 12180
Mosaic Associates Architects, DPC

ADDRESS ALL COMMUNICATIONS REGARDING THIS
PROJECT TO THE ARCHITECT AT THE ABOVE ADDRESS

To the best of my knowledge, information and belief, the plans and specifications are in accordance with applicable requirements of the 2020 New York State Uniform Fire Prevention and Building Code and the State Energy Conservation Construction Code, and State Education Department Building Standards. No new asbestos-containing materials (ACM) or lead materials (LM) shall be used in construction for the above referenced buildings. Work will involve known or suspected (ACM/LM) as evidenced by bulk or destruct testing, and will be REMOVED in accordance with Industrial Code Rule #56 and/or HUD guidelines and OSHA.

_____

Architect **February 1, 2021**

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DIVISION 22
PLUMBING SPECIFICATIONS (PC)
INDEX

SECTION 220010 - PLUMBING WORK GENERAL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all General Conditions, Supplementary Conditions, Division 1 specification sections as well as Information to Bidders requirements that are included in the project documents, apply to the work of this Contract.

1.02 ALLOWANCES, ALTERNATES AND UNIT PRICES

A. Refer to Division 1 specifications for allowances, alternates and unit prices required as part of this Contract.

1.03 INTENT

A. The intent of the drawings and these specifications is to provide all systems complete and operative. Whether indicated on the drawings and/or included in the specification or not, provide all materials, equipment and labor usually furnished with such systems.

1.04 DEFINITIONS

A. Provide: Furnish, install and connect.
B. Furnish: Supply material only.
C. EXR: Existing to remain.

1.05 SCOPE OF WORK

A. Drawings and specifications are complementary and must be so interpreted to determine the full scope of work under this section. Wherever any material, article, operation or method is either specified or shown on the drawings, this Contractor is required to provide each item and perform each prescribed operation according to the designated quality, qualification or condition, furnishing all necessary labor equipment and incidentals.

B. Specifically included, without limiting the generality of drawings and specifications are:

1. Plumbing fixtures and trim indicated.
2. New replacement valves for non-operational control valves.
3. Valves where indicated.
4. Hot and cold water lines, recirculating lines.
5. Connection to equipment "by others" as indicated.
6. Sanitary drainage and vent lines.
7. Connection to existing water and sewer mains.
8. Thermal insulation on hot and cold water systems.
9. Excavation and backfill for interior piping and structures.
10. Pressure reducing valve on cold water service where indicated on drawings.
11. Remove existing plumbing fixtures where indicated.
12. Gas piping and outlets where indicated.
13. Air compressor and piping as indicated.
14. Tests: This contractor shall furnish materials, equipment and labor and shall perform all work of testing of the plumbing systems as outlined hereinafter. Testing procedure shall include installation tests and operating tests.

1.06 TEMPORARY SERVICES

A. Temporary Heat: In accordance with Architect's specifications and/or conditions, contractor shall have the permanent heating system capable of providing heat to the new work areas when required. The term heating system shall include all work or components necessary to operate heating system. For temporary usage, it is not required that this work be in a finished condition, i.e., covers in place, etc. Cost of fuel consumed for temporary heat from permanent systems only shall be paid by owner.

B. The use of permanent system will be allowed only if the building is fully enclosed with no construction dust to clog heating/cooling coils, heat recovery components, fans, etc.

C. At the completion of work, Contractor shall turn over to the Owner all equipment used for temporary heat in a new, as purchased condition. Contractor shall replace filters with new ones, clean all components which shall include: unit casings, ductwork, grilles, diffusers, etc., re-lubricate all moving parts, replace belts if required and perform any other work necessary (as determined by Architect and Engineer) to put equipment in a "new" condition.

D. Contractor shall take all measures necessary to insure that dust, dirt, or debris does not enter air systems while in operation for temporary heat and shall change filters as often as necessary. Under no circumstances shall air handlers be allowed to operate with no filter in place.

1.07 CONTINUITY OF UTILITY SERVICES

A. It is of paramount importance that each utility service operate continuously and without interruption. Whenever this contractor plans to make changes or alterations to any existing utility service, such plans shall result in no or minimum service interruption or inconvenience to Owner. This contractor shall plan and schedule any change or alteration to an existing utility service with Architect and Owner. Such planning, timing, and/or scheduling shall be approved by both these parties.

1.08 CODES AND STANDARDS

A. All materials, equipment, and installations by this contract shall be in accordance with the latest editions of the following applicable requirements:

1. 2020 International Building Code, including all applicable amendments supplements to the following:
   a) 2020 International Building Code
   b) 2020 International Existing Building Code
   c) 2020 International Fire Code
   d) 2020 International Plumbing Code
   e) 2020 International Mechanical Code
   f) 2020 International Fuel Gas Code

2. 2020 Supplement to the New York State Energy Conservation Construction Code including all applicable amendments to the following:
   a) 2020 International Energy Conservation Code
   b) 2013 ASHRAE 90.1

3. 2020 Uniform Code Supplement (May 12, 2020)

4. Lead testing in school drinking water (10 CRRNY 67-4)

5. Conform to requirements of NEMA.

6. Liquefied Petroleum Gas Code - NFPA 58.

7. Bear label of Underwriters Laboratories, Inc.

8. National Electrical Code NFPA Article 70, latest edition.

9. New York State Health Code.

10. Local Utility Standards.

11. Local Municipal and/or City Standards.

12. Industrial Code Rule #4 and #14 (12NYCRR 4 and 14) (Standards for Boiler Installation).

13. Conform with applicable requirements of ASTM - Regulations and Standards for Pipe and Pipe Fittings.

14. Be in accordance with USAS - Code for Pressure Piping, latest edition.

15. For external and internal pipe insulations, have flame spread rating of 25 or less and smoke developed rating of 50 or less when tested in accordance with ASTM Standard E84.

16. Sheetmetal and Air Conditioning Contractor's National Association, Inc. (SMACNA), latest editions.

17. Conform with applicable requirements of Standard for the Installation of Air Conditioning and Ventilating Systems, NFPA 90A, and Code for Safety to Life from Fire in Buildings and Structures, NFPA 101.

18. Be in accordance with design standards outlined in ASHRAE Handbooks, latest edition.

19. Conform to requirements of Owner's insurance carriers.

1.09 SUBMITTALS AND SUBMISSION REQUIREMENTS

A. All submittals shall be in accordance with Division 1 requirements, the following requirements listed below, and also as indicated in each specification section. All submittals not complying with the listing above will be returned to the contractor without being reviewed. Rejection by Architect or Engineer of any items submitted shall require resubmittal of acceptable items.

1. Within (30) days after receiving signed contract or notice to proceed, submit to Architect for review complete descriptive dimensional data and ratings for equipment and materials proposed to be furnished and installed. Submit (8) copies of data unless otherwise specified by the architect.

2. All materials submitted shall clearly state the job name and specification section(s) that it applies to.

3. Any package containing more than one piece of equipment or material shall also contain a schedule clearly listing all items in submittal. Schedule page(s) shall also indicate project name and building name.

4. All submittals must be clearly marked using nomenclature used in this specification for proper item identification, schedule of usage's, model numbers, construction materials, performance, data, etc.

5. Projects involving multiple buildings must have the submittals separated by building. Submittals in which buildings are combined will not be accepted. (Exception: When specifically approved by engineer, basic materials may be submitted once.)

6. The contractor shall verify and insure that dimensions and elevations of equipment and structures to be used conform to the space allocated for the equipment on the drawings, and complies with existing conditions.

7. Submittals traced or copied from contract drawings are not acceptable and will be returned without review.

8. In the event material and/or equipment is installed prior to obtaining approval of shop drawings, and in the sole opinion of the Owner's Agent, this material and/or equipment does not meet the specifications, the Contractor shall be liable for the removal and the replacement at no additional cost to the contract.

B. Samples: When requested by Engineer, provide samples of both specified equipment and proposed substitutions for review by the Owner's Agent. Such equipment shall be delivered to a location designated, or erected at the job site as directed. When neither is physically possible, arrange for the Owner's Agent to visit an acceptable site where the proposed equipment can be inspected.

C. Substitutions:

1. Submittals for equipment or materials other than as specified shall be accepted for review by the Owner's agent.

2. Approval of substitute equipment shall be based on functional, physical and aesthetic compatibility to the equipment specified as determined by the Owner's agent and approved by the engineer.

3. Where substitute equipment is approved, the contractor shall be responsible for, and bear the cost of any necessary changes by his trade or other trades to make the system complete and operable.

4. Contractor is fully responsible for providing coordination between all trades affected by equipment substitution.

5. When requested, contractor shall submit layout drawings indicating new dimensions and arrangements of substituted equipment. Layout drawings shall indicate all revisions necessary for all services affected by substitution.

1.10 CUTTING AND PATCHING

A. This contractor shall bear the cost of all cutting and patching required by and for the installation of this work. This contractor shall perform all cutting and patching unless otherwise indicated on drawings or if directed by the Architect.

B. Patching of fire rated floors, walls, partitions, etc. shall be made using new materials equal to the fire rating of the existing.

C. Should changes, omissions or errors in this contract's work require cutting, patching or making alterations in any portion of new construction, such work will be performed by GC at this Contractor's expense.

D. Cutting and patching of roof surfaces and structures shall only be performed by a qualified contractor, as approved by the Architect. The work of this contract shall bear the cost of above mentioned cutting and patching. This contractor shall insure that existing roof warranties remain in force.

E. This contractor shall furnish lintels, sized to accommodate structure above opening, where cutting and patching is to be performed on load bearing walls. Contractor shall obtain written approval for all lintels prior to installation.

F. Cutting shall be done in a manner which will not adversely affect the strength of the building. Holes and openings shall be neatly cut so as to provide a finished appearance and shall be patched around the edge where required for a finished appearance. Provide temporary bracing, shoring, etc. as required.

G. Patching shall be structurally sound and match the existing materials and finish of adjacent materials. Patching is required in finished areas, wherever existing work is removed, at the sides of openings, etc.

H. At the completion of the work, all evidence of alteration will be as inconspicuous as possible.

1.11 FIELD INSPECTION

A. As there are various conditions at the site which do not show on the accompanying drawings, or which are at variance with the conditions indicated on the drawings, it is important that each bidder visit the site and acquaint himself with existing conditions, and take these conditions into consideration when preparing his proposal. Each bidder shall obtain information or make any measurement desired. Lack of knowledge relative to existing conditions will not be allowed as a basis for extra compensation.

B. This contractor and his subcontractors shall inspect existing equipment to remain prior to any of his new work in order to determine that all equipment is in good operating condition. If equipment is found to be lacking components, is inoperable, damaged, etc., contractor shall provide immediate written notice to the Owner. The Owner or his representative shall determine if any additional work is necessary and the method by which any work shall be performed.

1.12 INSTRUCTION SERVICES AND MANUALS

A. Instructions:

1. Provide competent personnel to remain at the jobsite for necessary time to instruct the Owner's personnel in proper operation and maintenance of installation made by this contractor.

2. This contractor shall be responsible for notifying and instructing Owner's personnel on all equipment operations, maintenance requirements, etc. Furnish operating training session(s) for equipment listed.

3. The Owner shall be responsible for establishing an operating and maintenance program for all equipment listed.

B. Training Session: A training session shall be held for each system and/or item listed below:

Item	Description	Training Hours For Each Bldg
1.	Flush Valves	1/2
2.	Hot Water System	1/2
3.	Compressed Air	1/2
4.	Grease Interceptor	1

5.	Dilution Trap Maintenance	1/2
6.	Emergency Shower Operation and Testing	1/2
7.	Tempered Water Valve Operation	1/2

C. The instruction shall include the following types of information:

1. System overview
2. Major component designation
3. System operation procedures
4. Maintenance scheduling and procedures
5. Provide a list of spare components each system would normally require

D. Services: Provide services required, for all equipment specified under this contract, for a period of (1) year after written acceptance by the Owner.

E. Manuals: Submit (3) sets of Operation and Maintenance manuals. Each set shall contain the manufacturers' data, operating instruction parts catalog and maintenance procedures for each piece of equipment. Include normal maintenance servicing schedule to be performed by the Owner.

1. For projects containing multiple buildings, manuals shall be submitted separately for each building.

1.13 PERMITS, CERTIFICATES AND FEES

A. This Contractor shall obtain and pay for permits, certificates, fees etc. listed below. Costs for permits, fees etc. shall be included in the Base Bid amount.

1. All required applications and permits to begin work
2. Certificate of inspection including Third Party Agent
3. All municipal connection charges
4. All local utility charges (gas etc.)
5. Fees and charges shall be obtained directly from the respective authority having jurisdiction

1.14 REMOVAL, DISPOSAL AND HAZARDOUS MATERIALS

A. All removed equipment shall be removed from the site and properly disposed of.

B. All hazardous materials must be disposed of in compliance with ENCON and all other regulatory agencies.

C. The Owner may wish to keep certain equipment, therefore, check with Owner before removals to determine what may be salvageable.

1.15 GUARANTEE

A. Contractor shall guarantee all work furnished through this contract including work performed by sub-contractors, for a period of (1) year (unless otherwise noted), from the date of final acceptance. Contractor agrees to repair or replace any defective work or materials at no additional cost to the Owner. Contractor shall also pay for any damage to other work resulting from repairs to defects. Contractor shall furnish written guarantees to the Owner's agent in accordance with the general conditions.

1.16 INSTALLATION

A. This contractor shall coordinate scheduling and installation of work with other contractors, sub-contractors and other trades. The contractor is also required to coordinate all work with owner supplied materials, direct contracts, and normal building operations, if any.

B. All finished work shall be neat and workmanlike. All work of a special nature shall be performed by skilled and qualified workmen who can present credentials showing experience in said trade. New systems shall be delivered to Owner complete in perfect working order, tested and balanced in full accordance with plans and specifications. Existing systems shall function in same manner as before this work was performed. Any malfunctions which arise in existing systems as a result of demolition or alteration of parts of such systems shall be corrected.

C. Layout of equipment, accessories and piping systems in plan is generally diagrammatic unless specifically dimensioned or detailed. Check project drawings and existing site conditions before installing work for interference's as governed by structural or other conditions. Owner reserves the right to make reasonable changes in location of equipment, accessories or piping systems prior to "roughing-in" without involving additional expense. Exact dimensions shown upon plans will be subject to verification and confirmation of exact conditions at site at time of construction. "Plus or minus" dimensions are shown upon drawing as a guide only. Exact surrounding conditions are governed by final equipment selection and/or other like details.

D. Furnish all new equipment and materials as described herein. Any material, operation, method or device mentioned, listed or noted within this specification, if not specifically mentioned as furnished or installed by others, shall be furnished and installed by this contractor.

1.17 TESTING AND INSPECTION

A. Inspections required for any ordinances, regulations, instructions, laws, rules, standards and practices that require any work to be inspected or tested shall be performed. Contractor shall give Owner, Architect and Engineer timely notice of readiness of work for inspection or testing and the date fixed for said inspection or testing.

B. Third-Party Agency must inspect completed installation and present Owner with Certificate of Inspection showing approval.

C. Required local or municipal inspection processed and present Owner with certificate indicating approval of such governing bodies.

D. Contractor shall submit a written report to Architect, copy to Engineer, on results of each inspection or test on system or equipment supplied. Report shall contain all pertinent information, recommendations, approvals, additional work required, etc.

E. Tests:

1. After installations are completed and before insulation is applied, walls are closed, or trenches backfilled, all portions of the installation shall be tested in accordance with the procedures described herein.

2. Provide hydrostatic pressure test for storm water sanitary and vent pipe with 10' or more developed length. Test pressure shall be a minimum of 10' water column at all points except the upper most portion of the roof vent or drain terminal. Piping shall be tested in sections with approved test plugs, duration of the test shall be one hour. In addition to the pressure test described above, Contractor shall provide a flow test for each section of the plumbing drainage systems to verify that there are no

blockages. All pipes must be exposed during testing unless otherwise approved by Engineer.

3. Interior domestic water piping shall be tested at 125 psi pressure. Contractor shall fill piping at the beginning of working day and maintain pressure for two hours with no pressure loss. If no leaks are found, the piping shall be allowed to remain under pressure overnight and then be inspected the next morning. No insulation shall be applied to the piping until the test is complete.

1.18 RECORD DOCUMENTS

A. When required by general conditions or other Division 1 Section this Contractor shall prepare and turn over to Owner's agent record As-built documents. As-built drawings will include actual equipment location layout, service connections, ductwork and piping layouts, valve locations, etc.

B. In all projects, contractor shall provide record drawings of all underground equipment and service runs. As-built drawings for underground work will include dimensions to actual locations finish grade elevations, and actual invert to underground structures equipment and service runs.

1.19 IDENTIFICATION AND NAMEPLATES

A. Provide engraved plastic labels screwed to equipment furnished under this contract including control panels, starters, switches, panels, etc. Labels shall have black background, white letters; minimum letter height 3/8" high, self adhesive labels or punch tape type labels are not acceptable.

1.20 PENETRATIONS THRU FIRE RATED CONSTRUCTION

A. All penetrations by this contract through rated construction shall be sealed fire safe by a UL listed approved method.

B. All piping penetrations through walls, floors, etc. shall be sleeved.

C. All piping penetrations through fire rated partitions, walls, floors, etc. shall be installed as follows; penetration shall be oversized 1/2" to 3/4" maximum. This contractor shall pack with fireproofing insulation, type FS cerablanket. Outside of penetrations (exposed surfaces around pipes and ductwork) shall be caulked and sealed with flame stop V, as manufactured by Flame Stop, Inc.; or an approved equal. Flame stop sealant shall be troweled smooth for finishing as required.

1.21 CONFINED SPACES

A. All work in pipe tunnels, mechanical pits, well manholes, etc. shall be performed by skilled tradesman and laborers with current certification for working in confined space. Contractor shall bear all costs to provide all safety equipment, ventilation, etc. as required by State and Federal Regulations and shall obtain all necessary permits for such work.

B. Contractor shall submit copy of current certifications and photo I.D. of all tradesman and laborers who will be working in confined spaces on this project.

1.22 COORDINATION DRAWINGS

A. Before construction work commences, Contractors for all trades shall submit Coordination Drawings at not less than 1/4" = 1'-0" scale. Coordination Drawings are required throughout all areas for all trades. These drawings shall identify and show resolutions of trade conflicts. Mechanical Equipment Rooms shall be drawn early in the Coordination Drawing process, simultaneous with all other congested areas. Prepare Coordination Drawings as follows:

1. HVAC Contractor will prepare the base plan Coordination Drawings showing all ductwork and all pertinent piping and equipment. The drawings shall be coordinated with cable tray, lighting fixtures, sprinklers, air diffusers, other ceiling mounted items, ceiling heights, structural work, maintenance clearances, electric code clearance, reflected ceiling plans, and other contract requirements. Reposition proposed locations of work after coordination drawing review by the Owner and the Architect. Provide adjustments to exact size, location and offsets of ducts, pipes, conduit, etc., to achieve reasonable appearance objectives. Provide these adjustments as part of Base Bid Contracts. Minor revisions need not be redrawn.

2. HVAC Contractor will provide prints and CAD drawings and submit the base plan to all major trades' Contractors.

3. Electrical, Plumbing and Fire Protection Contractors will draft location of piping and equipment on the base plan, indicating areas of conflict and suggested resolutions.

END OF SECTION

SECTION 220020 - CONCRETE WORK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the contract including the General and Supplementary conditions and Division 1 Specification Sections apply to the work of this Section.

1.02 SUBMITTALS

A. Concrete mix designs.
B. Reinforcing materials.
C. Shop drawings for reinforcing arrangements.
D. Concrete test reports.

1.03 QUALITY ASSURANCE

A. Comply with provisions of the following, specifications and standards, except where more stringent requirements are specified:

1. The American Concrete Institute (ACI) "Manual of Concrete Practice".
2. Applicable ASTM Standards.
3. Concrete Reinforcing Steel Institute (CRSI) "Manual of Concrete Practice".

PART 2 - PRODUCTS

2.01 FORM MATERIALS

A. Metal forms shall be clean, free from rust and free from dents.

B. Form lumber shall be new when used for the first time on this job.

C. Plywood shall comply with United States Product Standard PS-1 for Plyform Class 1, Structural 1, Exterior Grade B-B or better.

D. Form coating compounds shall be of a commercial formulation that shall not bond with, stain or adversely affect the concrete surface. Confirm that any form coatings to be used are compatible with any concrete finish to be applied.

2.02 REINFORCING MATERIALS

A. Reinforcing Bars (ReBar) - ASTM A615, Grade 60, deformed, shop fabricated.

B. Welded Wire Fabric (WWF) - ASTM A185, Welded steel wire fabric, in flat sheets only.

C. Provide supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting and fastening Reinforcing Bars and Welded Wire Fabric in place. Use wire bar type supports complying with CRSI Class III recommendations.

D. For slab-on-grade use supports with sand plates or horizontal runners where chair legs will damage vapor barrier.

2.03 CONCRETE AND GROUT MATERIALS

A. Cement shall conform to ASTM C-150 Type I.

B. Normal weight concrete aggregates shall conform to ASTM C-33.

C. Concrete shall conform to ASTM C-94 for Ready Mix Concrete. Concrete shall have a minimum 28 day compressive strength of 3000 psi using a minimum of six sacks of cement per cubic yard. The slump for all concrete shall not exceed 4".

D. Time limit for concrete delivery truck shall be a maximum of 45 minutes.

E. Admixtures shall be compatible with all other materials to be used and shall meet the following:

1. Air-entraining agent shall conform to ASTM C260. Air entrainment shall be between 5% and 7% in all concrete exposed to freezing and thawing.

2. Chemical admixtures shall conform to ASTM C494 and must be specifically approved by Architect prior to their inclusion into any concrete. Calcium chloride shall not be used in any form.

F. Grout shall be non-shrink, non-metallic, high strength (5000 psi minimum at 28 days) cementitious material.

2.04 RELATED MATERIALS

A. Moisture retaining cover shall comply with ASTM C171, including waterproof paper, polyethylene film and coated burlap.

B. Absorptive cover shall be burlap cloth from jute or kenot, weighing approximately 9 oz. per sq. yard complying with AASHTO M182, Class 2.

C. Water resistant barrier consisting of heavy kraft papers laminated together with glass-fiber reinforcement and over-coated with black polyethylene on each side.

D. Vapor barrier consisting of seven-ply membrane with reinforced core and carrier sheet with fortified bitumen layers, protective weathercoating and plastic anti-stick sheet. Water vapor transmission rate of 0.00 grains per sq. ft. per hour when tested according to ASTM E 96, Method B. Provide manufacturer's recommended mastics and gusset tape.

E. Bonding agents shall be a 2 part, high modulus, moisture insensitive, polysulphide free, rigid epoxy containing 100% solids and shall conform to ASTM C-881, Type 2, Grade 2, Class B; ASTM C-883; ASTM D-638 and ASTM D-695.

F. Provide for installation of inserts, sleeves, fastening devices, dowels, etc. as required.

2.05 TESTING

A. Independent testing laboratory shall prepare cylinders, transport for lab cured specimens, perform all testing, and submit written test reports.

B. Sample fresh concrete (ASTM C172) at time of delivery.

C. Slump (ASTM C143) one test for each days pour for each class of concrete.

D. Air content (ASTM C231), pressure method for normal weight concrete, one test for each days pour or each time compression test cylinders taken.

E. Compression test specimens (ASTM C31), 4 standard cylinders. Stone and cure at testing laboratory. Prepare one set for each truck. Log locations of each test specimen.

F. Compressive strength testing (ASTM C39), first test at (7) days, second test at (14) days, third test at (28) days and fourth cylinder held in reserve for backup testing if required.

G. Test reports shall indicate name of testing company, cylinder identification, sample location, date of placement, concrete type, design strength, actual strength.

PART 3 - EXECUTION

3.01 FORM WORK

A. Forms shall be constructed to conform to the required shapes, dimensions, line elevations and positions and shall be maintained sufficiently rigid and tight to prevent deformation under load and to eliminate cement leaks. Form surfaces shall be thoroughly cleaned for each use. Forms shall be oiled before reinforcing steel is placed.

B. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Bevel wood inserts for forming key-ways, recesses, etc. for easy removal.

C. Coordinate form-work installation with other trades.

3.02 REINFORCEMENT

A. Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars", for details and methods of reinforcement placement and supports, and as herein specified.

B. Accurately position, support and secure reinforcement against displacement. Locate and support reinforcing by metal chairs, runners, bolsters, spacers and hangers as required.

C. Place reinforcement to obtain at least minimum coverages of concrete protection. Arrange, space and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations.

D. Install welded wire fabric in as long lengths as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset end laps in adjacent widths to prevent continuous laps in either direction.

3.03 CONCRETE PLACEMENT

A. Pre-Placement Inspection: Before placing concrete, inspect and complete framework installation, reinforcing steel and items to be embedded or cast-in. Moisten wood forms immediately before placing concrete where form coatings are not used.

B. General: Comply with ACI 304, as herein specified.

1. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation.

C. Placing concrete in forms: Deposit concrete in forms in horizontal layers not deeper than 24" and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer in still plastic to avoid cold joints.

1. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI recommended practices.

2. Do not use vibrators to transport concrete inside forms.

D. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed.

1. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.

2. Bring slab surfaces to correct level with straightedge and strike off. Use bull floats or darbies to smooth surface, free of humps or hollows. do not disturb slab surfaces prior to beginning finishing operations.

3. Maintain reinforcing in proper position during concrete placement operations.

E. Cold Weather Placing: Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306.

F. Hot Weather Placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305.

3.04 SURFACE FINISHES

A. Rough Form Finish: For formed concrete surface "below grade" not exposed-to-view. This is the concrete surface having texture imparted by form facing material used, with tie holes and defective areas repaired and patched and fins and other projections exceeding 1/4" in height rubbed down or chipped off.

B. Trowel Finish: Apply trowel finish to interior equipment and housekeeping slab surfaces to be exposed-to-view. After floating, begin first trowel finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as a trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance and with a surface plane tolerance not exceeding 1/8" in 10' when tested with a 10' straightedge. Grind smooth any surface defects.

C. Non-Slip Broom Finish: Apply to exterior above or at grade slab surfaces. Immediately after trowel finishing, slightly roughen concrete surface by brooming with fiber bristle broom perpendicular to the short edge and finish slab perimeters with an edging tool.

D. Equipment Support Base Finish: Concrete surfaces of equipment support bases shall be finished per equipment manufacturer's recommendations.

E. Piers Finish: Top of piers shall be shaped to shed water and finish for support leg or equipment mount shall be per equipment manufacturer's recommendations.

3.05 CONCRETE CURING AND PROTECTION

A. Curing shall be accomplished by preventing loss of moisture, temperature change greater than 5°F in one hour to 50°F in any 24 hours, mechanical injury, or injury from rain or flowing water for a period of not less than (7) days. Curing compounds, if used shall be checked for compatibility with all finish coats.

B. Curing shall be started as soon as free water has disappeared from the concrete after placing and shall be accomplished by keeping the concrete surfaces damp. Where formed surfaces are cured in the forms, the forms shall be kept continually wet. If the forms are removed before the end of the curing period, curing shall be continued with moisture-cover curing method as described below.

C. Cover concrete slab surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3" and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

3.06 CONCRETE SURFACE REPAIRS

A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removal of forms. Cut out honeycomb, rock pockets, voids over 1/4" in any dimension and holes left by tie rods and belts, down to solid concrete but, in no case to a depth of less than 1". Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water brush-coat the area to be patched with specified bonding agent. Place patching mortar after bonding compound has dried.

B. Repair of Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to the satisfaction of the Engineer. Surface defects include: irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on surface. Flush out form tie holes, fill with dry pack mortar.

END OF SECTION

SECTION 220040 - EXCAVATION AND BACKFILL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract including the General and Supplementary Conditions and Division 1 Specifications Sections, apply to the work of this section.

1.02 SUBMITTALS

A. Product data for all materials; including but not limited to:

1. Each type of plastic warning tape.
2. Geotextile.
3. Controlled low-strength material, including design mixture.
4. Geofoam.

1.03 GENERAL REQUIREMENTS

A. Comply with requirements of governmental agencies having jurisdiction.

B. Locate underground utilities and coordinate their preservation.

C. Secure approvals of governmental agencies having jurisdiction and of adjacent property owners, if required.

D. The Contractor must examine all boring reports included in the Contract Documents prior to bidding this work. The presence of water or adverse soil conditions are not a basis for extra compensation.

E. Proceed with and complete grass and/or pavement area restoration work as rapidly as portions of site become available working within seasonal limitations.

F. Follow locations and elevations on drawings where applicable. Contractor shall coordinate work with existing conditions and final grade and configurations.

G. Inspect the areas and conditions under which excavating, filling and grading are to be performed. Commencement of excavating, filling and grading will constitute acceptance of conditions under which work is to be performed.

H. Any damage to underground utilities as a result of this work is the responsibility of the Contractor and must be repaired at no cost to the Owner.

1.04 PROTECTION OF PERSONS AND PROPERTY

A. It shall be noted and stressed that this contractor's installations will be made during a period when the existing building(s) are in use. Contractors shall schedule and conduct their operations so as to cause the least amount of inconvenience to the owner. Contractor shall provide all possible safe-guards to protect students and others at the site.

B. Barricade open excavations occurring as part of this work. Furnish night lighting as required.

C. Contractor shall furnish, erect and maintain barriers where feasible or directed to separate construction activities from other operations on site. Gates may be provided where required. Contractor shall limit operations and activities to fenced areas where applicable.

D. Protect structures, utilities, pavements and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards caused by earthwork operations.

E. Perform any shoring and bracing required to safely do the work required. Maintain sides and slopes of elevations in a safe manner. Provide necessary sheet piling and/or shoring needed for protection of workman, materials, buildings, other properties, and the public.

F. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces is not impeded.

G. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.

H. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

I. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.

J. Contractor is responsible for all sheet piling and shoring required, any sheet piping provided is to be installed under supervision and approval of a Certified Professional Engineer.

1.05 EXISTING UTILITIES

A. Locate existing underground utilities in areas of work. If utilities are to remain in place, provide adequate means of support and protection during earthwork operations.

B. Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect, and then only after arranging to provide temporary utility services according to requirements indicated.

1. Notify Architect not less than (2) days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.
3. Contact utility-locator service for area where Project is located before excavating.

C. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner and Architect immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to the satisfaction of the utility owner.

1.06 WATER CONTROL

A. Contractor shall furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control ground-water flow into excavations if required and permit construction to proceed on dry, stable subgrades.

1. Maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood, and that damage to subgrades and permanent structures is prevented.
2. Prevent surface water from entering excavations by grading, dikes, or other means.
3. Accomplish dewatering without damaging existing buildings adjacent to excavation.
4. Remove dewatering system if no longer needed.

B. It is the responsibility of the Contractor to examine all available information prior to bidding to determine existing water table elevation. Dewatering must be covered in Base Bid, no extra compensation for dewatering will be allowed.

C. Comply with water disposal requirements of authorities having jurisdiction.

D. Installation: Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

E. Before excavating below ground-water level, place system into operation to lower water below excavation depth. Operate system continuously until construction is complete and fill materials have been placed, or until dewatering is no longer required.

F. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.

G. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed.

1.07 PIPING TRENCH EXCAVATION

A. Excavation shall allow for direct buried anchors. The trench bottom must give uniform support along the entire length of any pipelines. Where several pipelines are located in a common trench, the trench must be wide enough to maintain the specified distances between adjacent lines. The excavation should be in a straight line except where fittings are located.

B. The width of the trench at the top of the pipe should be held to the minimum required for efficient and proper installation but in accordance with current OSHA Standards.

C. Where suitable soil exists, pipe shall be installed to comply with ANSI/AWWA C151/A21.51 Laying Condition Type 2. This shall consist of a flat bottom trench with undisturbed earth backfilled and lightly consolidated to centerline of pipe. Where drainage pipe is installed, bottom of trench shall be uniformly sloped. In all cases, pipe bells shall be excavated to provide uniform support.

D. Where unsuitable material exists, pipe shall be installed to comply with ANSI/AWWA C151/A21.51 Laying Condition Type 4. This shall consist of a pipe bedded in sand, gravel or crushed stone ASTM D2940; except 100% passing a 1" (25mm) sieve and not more than 8% passing a No. 200 (.075mm) sieve; to depth of 1/8 pipe diameter, 4" minimum. Backfill compacted to top of pipe 80% Standard proctor factor AHSHTO T-99.

E. If necessary to remove unsuitable material to a depth greater than specified, refill excavations carried below the depth indicated or directed with specified bedding material in 6" lifts compacted to 95% of maximum density in accordance with ASTM D1557, Method D. Excavate and replace soil disturbed and weakened by the Contractor's operations or soils permitted to soften from exposure to weather, with bedded material and compact with a plate-type vibratory compactor to the specified density.

1.08 REMOVALS

A. Perform the work of demolition at the existing sites as indicated on the drawings and/or as required by the new construction. All materials removed shall be examined by the Owner. Those materials designated by the Owner as "scrap" shall become the property of the Contractor and removed from the site; Materials to be retained by the Owner shall be delivered to the Owner at location as directed.

B. All excess soil removed from excavations, existing concrete sidewalks, etc. not to be reused as backfill, shall be trucked from the site and disposed of by the Contractor.

1.09 MAINTENANCE & REPAIR OF EXISTING FACILITIES

A. Before work is started, the contractor shall inspect the existing work which will be affected by his operations. For the contractor this will include, but is not limited to, driveway, roads, lawn area, walks, shrubbery, etc.

B. Contractor shall report in writing any observed defects to the Owner in order to avoid his being held responsible for damage which may not be his fault.

PART 2 - PRODUCTS

2.01 SUITABLE BACKFILL MATERIAL

A. Excavated or borrow material shall be predominantly granular, non-expansive and free from roots, rocks or lumps over 3" and deleterious matter.

1. Gravel: Run of bank gravel, reasonable free of loam, silt and clay.

2. Stone: Select, graded crushed stone, free from organic, frozen or deleterious matter.

2.02 GRASS RESTORATION

A. Grass Seed: Provide fresh, clean, new-crop seed complying with tolerance for purity and germination established by Official seed Analysts of North America.

Grass seed Mixture:

% By Weight	Purity Species or Variety	Germ Pct.	Max. Pct.	Weed Content %
30%	Kentucky Blue	85%	80%	0.50
50%	Chewing Red Fescue	98%	85%	0.50
10%	Perennial Rye	98%	90%	0.50
10%	Annual Rye	92%	90%	0.75

B. Fertilizer: Provide fertilizer with not less than 10% nitrogen, 10% phosphoric Acid and 5% potash. Complete organic, slow-release type fertilizer of neutral character.

C. Lime: Natural dolomitic limestone containing not less than 85% of total carbonates with a minimum of 30% magnesium carbonates, ground so that not less than 90% passes a 10-mesh sieve and not less than 50% passes a 100-mesh sieve.

D. Topsoil: Provide acceptable topsoil free of roots, plants, sods, stones, clay lumps and other extraneous materials harmful or toxic to grass growth.

2.03 MATERIALS

A. Provide materials that are either new or in serviceable condition. The Contractor is responsible for determining what materials and methods are required to properly shore all excavations.

B. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.

C. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.

D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of 3 inches.

E. Cast-in-Place Concrete: ACI 301, of compressive strength required for application (3000 psi unless otherwise noted in Contract Documents).

F. Reinforcing Bars: ASTM A 615/A 615M, Grade 420, deformed, size as shown on Contract Drawings.

2.04 SOIL MATERIALS

A. Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Sand: ASTM C 33; fine aggregate, natural, or manufactured sand.

2.05 GEOTEXTILES

A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2; AASHTO M 288.
2. Grab Tensile Strength: 157 lbf; ASTM D 4632.
3. Sewn Seam Strength: 142 lbf; ASTM D 4632.
4. Tear Strength: 56 lbf; ASTM D 4533.
5. Puncture Strength: 56 lbf; ASTM D 4833.
6. Apparent Opening Size: No. 40 (0.425-mm) sieve, maximum; ASTM D 4751.
7. Permittivity: [0.5] per second, minimum; ASTM D 4491.
8. UV Stability: 50 percent after 500 hours exposure; ASTM D 4355.

B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2; AASHTO M 288.
2. Grab Tensile Strength: 247 lbf; ASTM D 4632.
3. Sewn Seam Strength: 222 lbf; ASTM D 4632.
4. Tear Strength: 90 lbf; ASTM D 4533.
5. Puncture Strength: 90 lbf; ASTM D 4833.
6. Apparent Opening Size: No. 60 sieve, maximum; ASTM D 4751.
7. Permittivity: 0.02 per second, minimum; ASTM D 4491.
8. UV Stability: 50 percent after 500 hours exposure; ASTM D 4355.

2.06 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored as follows:

B. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:

1. Red Electric
2. Yellow Gas, Oil, Steam, and Dangerous Materials

3.	Orange	Telephone and other Communications
4.	Blue	Water Systems
5.	Green	Sewer Systems

PART 3 - EXECUTION

3.01 EXCAVATION

A. Perform excavation of all types of materials encountered within the limits of the work. Unless otherwise noted, all excavations shall be open cut.

B. Excavate accurately to the cross sections, grades and elevations shown on the drawings or as required to run proper pitches and set invert elevations.

C. When rock or other unsuitable material is encountered, remove an additional 6" and fill to the proper grade.

D. Maintain excavations free from water.

E. Use necessary means to prevent dust from becoming a public nuisance.

F. Protect excavation bottoms against freezing when temperature is less than 35°F.

G. Use means necessary to avoid displacement and injury to pipe, conduit and structures by heavy construction machinery.

H. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade and shape stockpiles for proper drainage.

I. Locate and retain soil materials away from edge of excavation.

J. Dispose of excess soil material and waste materials as specified by Owner.

K. The bottom of trenches shall be accurately graded to provide uniform bearing and support. Wet or otherwise unstable soil that is incapable of properly supporting the equipment or pipe, as determined by the Architect, shall be removed to depth required and excavation backfilled to proper grade with gravel.

3.02 BACKFILL AND FILL

A. Place suitable soil materials in layers as required for each area classification listed below:

1. In excavations, use suitable excavated or borrow material.
2. Under concrete walks and slabs, use gravel, to 8" compacted thickness.
3. Under building slabs and within foundations walls, use gravel, up to a 6" compacted thickness.

B. Backfill excavations as promptly as work permits, but not until completion of inspection, testing approval, and recording locations of underground utilities.

C. Placement and compaction: Place backfill and fill materials in layers of not more than 8" in loose depth. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density. Do not place backfill on surfaces that are muddy, frozen or containing frost or ice.

D. Place backfill and fill material evenly adjacent to structures. Take care to prevent wedging of backfill against structures by carrying the material uniformly around structures to approximately the same elevation in each layer.

E. All excavations shall be carefully backfilled with materials approved for backfilling. Backfill for piping trenches shall consist of earth loam, sand and gravel, or approved material, free from large clods of earth or stones. Backfill shall be deposited in eight inch (8") layers, thoroughly and carefully rammed, until the pipe and tanks have a cover of not less than two feet (2'). Remainder of backfill material shall than be placed into trench in one foot (1') layers and tamped. Any trenches improperly backfilled shall be re-opened to depth required for proper compaction, then refilled and compacted with surface restored to required grade and compaction.

3.03 COMPACTION

A. Control soil compaction during construction to provide the minimum percentage of density specified for each area.

B. Provide not less than the following maximum density of soil material for each layer of actual material in place.

1. Lawn and Unpaved Areas: Compact the finished 8" and each layer of subfill to 90% modified proctor.
2. Walks and Paved Areas: Compact the finished 8" and each layer of subfill to 95% modified proctor.

3.04 GRADING

A. Uniformly grade areas within limits of this work, including adjacent transition areas. Compact with uniform levels or slopes between finished elevations and adjacent existing grades.

B. Grade areas to achieve drainage away from structures and to prevent ponding.

C. Soft spots are to be re-excavated and backfilled with suitable material.

3.05 COMPACTION TESTING

A. Where required, compaction testing shall be performed for each fill or backfill lift level at location frequency specified herein.

B. Proceed with subsequent earth moving and/or paving or equipment placement only after test reports comply with project requirements.

C. Work put in place with non complying conditions will be replaced, at contractor's expense, at the direction of architect or engineer.

D. For non compliance areas as materials are being replaced, retest and submit reports as required until specified conditions are met.

E. Compaction Testing Frequency:

1. Test at each sub grade and compacted fill or backfill layer.
2. Test frequency shall be (1) one test for each area dimension indicated. Where total is within frequency shown a minimum of (2) two test are required.

Area Type	Minimum Test Frequency
Trench	150 ft trench
Foundation	100 ft length or at each trench intersection with foundation
Roadway Paving	300 ft2
Sidewalk Paving	500 ft2
Building Slab	500 ft2 or at trench lengths 100 ft

3.06 MAINTENANCE

A. Protect newly graded areas from traffic and erosion and keep free of trash and debris.

B. Where compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, re-shape and re-compact to required density.

3.07 DISPOSAL OF EXCESS AND WASTE MATERIALS

A. If specifically directed by Owners Representative, transport acceptable excess excavated material to designated soil storage areas on the Owner's Property.

B. Remove unacceptable excavated material, trash, and debris resulting from this work, from the Owner's property and legally dispose of it.

END OF SECTION

SECTION 220519 - METERS AND GAUGES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this section.

1.02 SUBMITTALS

A. All items in this section under Part 2 - Products.

PART 2 - PRODUCTS

2.01 THERMOMETERS

A. Provide where shown on drawings or called for in specifications.
B. Acceptable Manufacturers: Ashcroft and Weiss.
C. TH-1: Weiss bi-metal type dial thermometer 5" Vari-Angle #5VBM 2 ½" stem length. Adjustable connection location 1/2" NPT connection. Scale calibrated in 2° divisions from 0°F to 250°F. Provide with thermowell to match stem length as required.

2.02 PRESSURE GAUGES

A. Provide where shown on drawings, called for in specifications, or where water services enter building.
B. Acceptable Manufacturers: Ashcroft and Weiss.
C. PG-1: Weiss LF401 Liquid Filled 4" Diameter Bronze. 1% accuracy, ¼" or ½" NPT 0-200 PSI range, 2° deg. F intervals. Provide with pressure snubbers and brass gage cocks.

PART 3 - EXECUTION

3.01 THERMOMETER INSTALLATION

A. Install thermometers in vertical and tilted positions to allow reading by observer standing on floor.
B. Thermometer Wells: Install in piping tee where thermometers are indicated, in vertical position. Fill well with food grade oil and secure cap.

3.02 PRESSURE GAUGE INSTALLATION

A. Install pressure gauges in piping tee with pressure gauge valve located on pipe at most readable position.

B. Install in the following locations and elsewhere as indicated:

1. At suction and discharge at each pump.
2. At discharge at each pressure reducing valve.
3. At building water service entrance.

3.03 ADJUSTING AND CLEANING

A. Adjusting: Adjust faces of meters and gauges and factory finished surfaces. replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touch-up paint.

END OF SECTION

SECTION 220523 - VALVES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this section.

1.02 SUBMITTALS

A. All valves other than design equipment.

B. Operating and Maintenance Instruction Manual and Parts List.

PART 2 - PRODUCTS

2.01 VALVES

A. General: Valves shall have following requirements:

1. Working pressure stamped or cast on bodies.
2. Ball valves, stem packing, serviceable without removing valve from line.
3. All valves must comply with ANSI 372 for lead free plumbing products.

B. Make

1. Gate, globe and check valves: Walworth, Stockham, Milwaukee, Nibco.
2. Butterfly Valves: Nibco, Milwaukee, Stockham, Watts.
3. Ball valves: Nibco, Apollo, Milwaukee, Jomar.
4. Balancing valves: Same as ball valves but with memory stop.
5. For convenience in designating type, design, etc., certain numbers are given hereinafter as "Design Equipment."

C. Valve Types:

1. Gate Valves: (Use only where indicated)
   a) 2" and Smaller: bronze, renewable seat, plug type, disc, union bonnet, rising stem, Class 200, screwed ends, Stockham Model #B-62.

   b) 2-1/2" and Larger: rising stem resilient wedge, OS&Y Class 150 flanged, 200 psi, non-shock water working pressure, epoxy coated body, Stockham Model #G610; Nibco Model #F-607-RW.

2. Globe Valves: (Use only where indicated)
   a) 2" and Smaller: Bronze, renewable seat teflon disc, union bonnet, rising stem, Class 150, screwed ends, Stockham Model #B22T.

   b) 2-1/2" and Larger: Bronze renewable seat teflon disc, rising stem, union bonnet, solder ends, Class 150, Stockham #B24T.

3. Check Valves:

   a) 2" and Smaller: Bronze body, TFE seat and disc., silent check, screwed ends, Class 125, Nibco Model #T-480-Y-LF, conforms to MSS SP-110, ANSI 372.

b) 2-1/2" and Larger: Wafer style, silent check, renewable seat and disc, spring activated, globe style, LB W.O.G., Nibco Model #W-910.

4. Ball Valves:
   a) 2" and Smaller: Bronze body 2-piece full port with chrome plated bronze ball. TFE seats and seals, 600 psi WP, W.O.G. screwed ends; Nibco Model #T-685-80-LF, conforms to MSS SP-110, ANSI 372.

5. Valves for Gauges, Instruments, etc.:
   a) 1/4" Size: Brass bar stock for 1000 psi and 300°F; Trerice #735 Needle Valve, or approved equal.

6. Plug Valve: Homestead lubricated plug valve, UL listed, threaded for sizes up to 2" flanged for sizes 2-1/2" above valve size to match pipe size indicated.

2.02 STRAINERS

A. 2" and Smaller: Bronze body, IPS connection, "Y" type, 20 mesh stainless steel screen, tapped bronze retainer cap for closure plug, bronze plug, 125 WSP. Watts 777S Series.

B. 2-1/2" and Larger: Iron body flanged "Y" type, ASTM #A-126, Class B, with blow-off connection, self-aligning 1/16" perforated stainless steel cylindrical screen. 125 psi WSP. Watts 77F Series.

PART 3 - EXECUTION

3.01 GENERAL

A. Provide valves of type called for and where shown and/or specified, and where required to service equipment whether or not shown.

B. Provide at all major building or systems sections whether or not shown.

C. Install all valves with stems at or above horizontal positions and all swing check valves in horizontal position only.

D. Ball valves may be used in place of gate valves for water service through 2" size at contractor's option, unless otherwise noted.

E. Provide new valves (size to match existing) for any existing non-operational valves which are required to allow for new installations to be made.

3.02 PLUMBING SYSTEM

A. Install valves on all branch lines leaving mains and serving two fixtures or more; to isolate each piece of equipment or fixture, for future connections and where indicated.

B. Use balancing valves on domestic water re-circulation lines.

END OF SECTION

SECTION 220553 - PIPE IDENTIFICATION & VALVE TAGS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including the General and Supplementary Conditions, apply to the work of this section.

1.02 IDENTIFICATION

A. Pipe Identification Markers: Furnish and install pipe identification markers on all piping installed under this contract, to consist of self-adhesive labels of black letters imprinted on color coded background indicating pipe fill and direction of flow. Lettering shall be 2" high on pipes 3" in diameter and over and 3/4" high on pipes under 3". Markers shall be applied to pipe, or to insulation in case of insulated pipes, on 15' centers, at branch take-offs and at each valve, whichever is closer.

B. Refer to schedule below for piping system, background color and lettering color.

C. Pipe Identification Schedule

	System I.D.	Background	Lettering
1.	Domestic Cold Water	Green	White
2.	Domestic Hot Water	Yellow	Black
3.	Domestic Hot Water Recirculation	Yellow	Black
4.	Sanitary Sewer	Green	White
5.	Storm Water Sewer	Green	White
6.	Natural Gas	Yellow	Black
7.	Liquefied Petroleum Gas	Yellow	Black
8.	Compressed Air	Blue	White
9.	Acid Resistant Sewer	Yellow	Black
10.	Acid Resistant Vent	Yellow	Black
11.	Sanitary Sewer Vent	Green	White
12.	Condensate Drainage	Yellow	Black
13.	Fire Protection Water	Red	White
14.	Fire Sprinkler Water	Red	White
15.	De-Ionized Water	Green	White
16.	Fuel Oil Supply & Return	Yellow	Black
17.	Non-Potable Water	Yellow	Black

D. Equipment Nameplates and Valve Tags: Identify each valve, control entity or piece of equipment with stamped brass or engraved plastic nameplate permanently attached by riveting, wiring, etc. Set up complete identification system in accordance with Owner's Physical Plant Department. Each drain plug or valve shall be tagged "DRAIN". Embossed and/or pressure sensitive plastic tape labels shall not be acceptable. Furnish engraved 2" x 1" black rigid laminated plastic nameplate for each motor starter to EC for mounting. Furnish framed valve chart indicating valve number, location and usage for all valves installed under this contractor.

END OF SECTION

SECTION 220715 - INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this section.

1.02 SUBMITTALS

A. Manufacturer data for all materials used in Contract.
B. Submit schedule of insulation applications.
C. Samples, only when requested.

1.03 QUALIFICATIONS

A. Installation of thermal insulation shall be made by competent mechanics regularly employed by and under the direct supervision of a qualified, approved insulation subcontractor.

B. All materials shall be installed per manufacturer's written recommendations and specifications.

C. All insulation, jackets, adhesives, and coatings, unless specifically modified, shall comply with the following:

D. Any treatment of jackets or facings for flame and smoke safety must be permanent. Water soluble treatments prohibited.

E. Insulation, including finishes and adhesives on the exterior surfaces of ducts, pipes, and equipment, shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less as determined by an independent testing laboratory in accordance with American Society for Testing and Materials Standard E 84, NFPA 255 and UL 723. Also, same shall comply with NFPA 90A, when installed in air plenums.

F. Work shall not commence until building is enclosed and roofs are watertight. Obtain approval from Architects before commencing work.

PART 2 - PRODUCTS

2.01 PIPE INSULATION (RIGID TYPE)

A. Pre-formed rigid sectional pipe covering, with factory applied jacket. Material, jacket type and thickness as specified hereinafter.

B. Insulation Material: Fiberglass.

C. Conductivity: Maximum thermal conductivity (k), on a flat surface, shall be 0.25 Btu/sq. ft. hr. °F/inch mean temperature.

D. Jackets: White Kraft outer surface bonded to aluminum foil and reinforced with fiberglass yarn permanently treated for fire and smoke safety and to prevent corrosion of the foil.

2.02 ACCEPTABLE MANUFACTURERS

A. Fiberglass: Johns-Manville, CGS, (Certainteed), Owens-Corning, Knauf.
B. Adhesives: Benjamin Foster or equivalent. Benjamin Foster (BF) numbers are used, unless otherwise noted, for convenience in designating quality of adhesive.

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

A. "Concealed" is generally intended to mean Work within or behind various construction elements, either fixed or removable, or in crawl spaces or trenches, which are not exposed to view when project is complete.

B. "Exposed" is generally intended to mean anything exposed to view when project is complete; as opposed to "concealed."

C. Provide Thermal Insulation:

1. Insulation is required on all piping unless otherwise indicated on Contract Documents.

2. Only on clean, dry surfaces and after piping ductwork and equipment have been tested and found to be tight.

3. On cold surfaces with continuous unbroken vapor seal.

4. All exposed surfaces shall be white.

5. Pipes individually insulated.

6. Domestic cold water, hot water and hot water return piping-hanger installed around piping insulation. Provide insulation shields.

7. On Sanitary drains for fixtures accessible to the disabled.

8. On all roof drain bodies and storm water piping.

D. Miscellaneous:

1. Install insulation on exposed hot and cold plumbing piping to within 18" of fixture or equipment connection.
2. Insulate hot and cold piping longer than 18" located inside sink cabinets, under counters, under tables, etc.

3.02 PIPE INSULATION (RIGID TYPE)

A. Apply insulation on all systems piping including fittings, flanges, unions, strainers, and other miscellaneous attachments installed in piping system, whether exposed or concealed, except where omitted or specified to contrary.

B. Any piping in exterior walls, spaces, overhangs, attics, or where subject to freezing: Insulate pipe with double the thickness specified. Where in wall chases: In addition to the above, pack chase with loose glass fiber insulation.

C. Hanger Shields: Required on all piping.

D. Joints in Section Pipe Covering Made as follows:

1. Standard: Longitudinal laps and butt joint sealing strips cemented with BF 85-20 or Armstrong 520. May be stapled with outward clinching staples where concealed or recovered. Factory applied pressure sensitive adhesive lap seal may be used at contractor's option. Adhesive shall be in two strips -- one, applied to the longitudinal jacket and the other on the opposing jacket surface.

2. Vapor barrier: Provide for all cold services. Longitudinal laps and 4" vapor barrier strip at butt joints shall be sealed with white BF 85-20 or Armstrong 520. Seal ends of pipe insulation at valves, flanges, and fittings and at butt joint approximately every 21' with white BF 85-20.

E. Fittings, Valves and Flanges:

1. Concealed & Exposed: Premolded fitting covers of the same material and thickness as the adjacent pipe insulation and finished with glass cloth applied and coated with BF 30-36 "Seal-Fas".

2. Optional: In lieu of the standard method above, the Contractor has the option of using "Zeston" methods, or Ceel-Tite System provided:
   a) Appearance and workmanship are acceptable to the Architects.
   b) Insulation values at least as great as specified must be maintained.
   c) Application details and manufacturer specifications shall be followed and are hereby made a part of the Contract Documents.

3.03 PIPE INSULATION MATERIALS

A. Schedule of Piping Insulation:

Service	Material	Insulation Thickness
Domestic Cold-Water	Glass Fiber	All sizes-1"
Domestic Hot Water	Glass Fiber	105-140 deg f = 1” 141- 180deg f =1.5”
Domestic Hot Water Recirculation	Glass Fiber	105-140 deg f = 1” 141- 180deg f =1.5”
Roof Drains, Storm and Drainage Piping	Glass Fiber	All sizes-1/2"
Condensate Drainage Piping	Glass Fiber	All sizes-1/2"

B. Note: Jacket material, finish, fitting covers, etc. (for all piping) shall be as specified for "exposed" and/or "concealed" application. Color shall always be white unless specifically approved otherwise.

C. Insulation Covers for Piping and Pipe Fittings: Provide PVC (Zeston) type insulation covers for all exposed insulated pipe and pipe fittings, other than Mechanical Rooms. Cover shall be fastened with a vandal resistant system and as specified.

D. Cover system shall be installed from floor to ceilings, complete. In areas where a ceiling is not present cover system shall be provided from the floor to 10' 0" above finished floor.

END OF SECTION

SECTION 221116 - PIPING SYSTEMS & ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this section.

1.02 SUBMITTALS

A. All items specified in this section under Part 2 - Products.

PART 2 - PRODUCTS

2.01 GENERAL

A. All pipe and fittings new and marked with manufacturer's name; comply with applicable ASTM and ANSI Standards.

B. All water piping fittings must comply with ANSI 372 for lead free plumbing products.

2.02 STEEL PIPING AND FITTINGS

A. Pipe: ASTM A-120 or ASTM A-106 seamless or ERW Schedule 40, or extra strong (Schedule 80) weight; black or galvanized finish as called for.

B. Fittings: Same material and pressure class as adjoining pipe.

1. Cast iron fittings: Screwed connection, cast or malleable iron, black or galvanized; drainage type where called for.

C. Flanges, Unions and Couplings:

1. Screwed connections:
   a) Unions: ASR malleable cast iron, bronze to iron seat, 300 lb. wwp; use for sizes 2" and smaller.

2. Gauge and Instrument Connections: All nipples, plugs, etc., for adapting gauges and instruments to piping system shall be IPS brass.

2.03 COPPER PIPE AND FITTINGS

A. Pipe: Hard temper, ASTM B-88; Type K, L, M, or DWV, as called for. Soft temper only in specific cases. Plans show copper tube sizes.

1. Copper is not allowed for urinal waste.

B. Tees, Elbows, Reducers: Wrought copper or cast bronze; solder end connections; ASTM B-62, ANSI B16.22. mechanical fittings ASTM B-88

C. Unions and Flanges: 2" and smaller use unions, solder type, cast bronze, ground joint, 150# swp; 2-1/2" and over use flanges, cast bronze, companion type, ASME drilled, solder connection, 150 swp. Bolts shall be same as for steel pipe.

D. Press Fittings: Bronze or copper shall conform to the material requirements of ASME B16.18 or ASME B16.22, and the performance requirements of IAPMO PS117, and ICC LC1002. Press fittings 1/2-inch thru 4-inch for use with ASTM B88 copper tube type K, L, or M and 1/2-inch up to include 1-1/4-inch annealed copper tube. Press fittings shall have either an EPDM, FKM, or HNBR sealing element and integral detection feature intended to identify un-pressed fittings. 2-1/2-inch thru 4-inch shall have a 420 stainless steel grip ring, PBT separator ring, EPDM or FKM sealing element and integral detection feature. Sealing elements shall be factory installed and shall be verified for the intended use.

1. Note: Only Press fittings with EPDM sealing element that conform to NSF 61-pw shall be installed in a potable water system.
2. Acceptable Manufacturers: Veiga ProPress, ApolloPRESS or Nibco.

2.04 SOIL PIPE AND FITTINGS

A. All cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and be listed by NSF International.

B. Pipe: ASTM A-74 service weight cast iron, coated.

C. Fittings: Service weight type with neoprene gasket of same manufacturer as piping, acceptable for piping buried only in earth.

D. No-Hub (Above Grade Only):

1. Pipe: ASTM C-564 no-hub cast iron, coated.

2. Fittings: Cast iron no-hub pattern with heavy-duty rubber gasket and stainless steel clamp assembly. Mission Rubber or equal. ASTM # 1540, ASTM C564.

2.05 SPECIAL FITTINGS

A. Cast Iron to Lead Pipe:

1. Red brass ferrules and wiped joints.
2. Caulk ferrule into cast iron hub.

B. Copper to Steel Piping

1. Cast bronze copper to iron male or female adapter with shoulder.
2. Use dielectric pipe fittings where required.

C. Steel to Cast Iron: Cast iron soil pipe connector with spigot and IPS male thread end (Manhoff fittings).

D. No-Hub, or Cast Iron: Proper adapter to piping being connected.

2.06 DIELECTRIC PIPE FITTINGS

A. Tensile strength, Federal Specification WW-U-531A, union or flange design, 250 psi pressure rating, threaded or solder joint, constructed to prevent gasket from squeezing into internal opening.

B. Make: Epco or equivalent.

2.07 CHEMICAL RESISTANT WASTE AND VENT PIPING

A. General: The material includes connecting fittings in stacks or mains.

B. Polypropylene Plastic: ASTM D2146, Schedule 40, flame retardant. Pipe and fittings shall be joined by mechanical joint. Must conform to National Sanitation Foundation requirements for corrosive waste service. Short turn elbows and sanitary tees will not be permitted. Use standard DWV pattern for fittings. Orion Blue Line Flame Retardant or equal.

2.08 HANGERS, INSERTS AND SUPPORTS

A. Hangers, Inserts, Clamps, Etc.: Carpenter & Patterson, Central Iron, Elcen, Fee & Mason, Grabler and Grinnell.

B. Hangers: Adjustable, steel clevis type, cadmium plated or galvanized except where in contact with copper piping. Copper plated or PVC coated where in contact with copper piping.

C. Hanger Shields: Required on all piping.

D. Spacing Schedule:

Pipe Size	Steel (ft)	Copper (ft)	No-Hub Cast Iron *	Rod Size
3/4" to 1"	12	6	Each	3/8"
1-1/4" to 1-1/2"	12	6	Horizontal	3/8"
2" to 4"	12	10	Joint	1/2"
5" and Over	12	10	5 Feet	5/8"
8"	12	10	Maximum O.C.	3/4"

*Cast iron "No-Hub" to be supported on all sides of fittings & Joints

E. Piping systems with material not listed in above schedule shall be supported and protected in accordance with manufacturer's recommendations and as approved.

F. Inserts: Equal to Grinnell Fig. #281, maximum loading l000 lbs., galvanized finish, and Fig. #285, maximum loading 400 lbs. Use approved beam clamps if possible.

G. Supports:

1. For Weights Under 1000 lbs.: Support all Contract Work with approved type "Drill-In" inserts equal to "red Head," "unistrut," beam clamps or other structurally approved support. The factor of safety shall be at least four (4). Follow manufacturer's recommendations.

2. For Weights Above 1000 lbs.: Drill through floor slabs and provide flat flush plate bolted to top of rod or provide additional "Drill-In" inserts and hangers to reduce load per hanger below 1000 lbs.

3. For Metal Decks: Drill hole through for hanger rods and imbed a bolted plate in concrete or use Phillips "Red Head" devices designed for this application. All cases must have safety factor of four (4).

H. Trapeze Hangers:

1. Use for plumbing systems only.

2. Hangers shall be supported with rod size per above schedule.

3. May be "Kindorf" or Unistrut" manufactured type or suitable angle iron or channel.

4. Securely fasten to trapeze with "U" bolt or straps, dissimilar metals shall not touch, otherwise use isolation gaskets.

2.09 PIPING ACCESSORIES

A. Escutcheon Plates: Steel or cast iron polished chrome, split hinge type with setscrew, when used at ceiling and floor locations. Special high plates where required for extended sleeves. Chrome plated in vicinity of all fixtures. Provide escutcheons at all pipe penetrations thru ceilings, floors and walls exposed to view.

2.10 SLEEVES

A. Standard Type: Schedule 40 black steel pipe sleeves, two pipe sizes larger than the pipe, required for all structural surfaces.

B. Sheet metal sleeves permitted only for nonstructural surfaces and existing construction. Sheet metal sleeves shall be 18 gauge minimum and shall be properly braced to prevent collapsing.

2.11 SEALING ELEMENTS

A. Waterproof Type: Synthetic rubber material with zinc plated bolts equal to "Link-Seal" Series 200, 300 or 400.

2.12 PIPING MATERIALS (PLUMBING)

A. Water Distribution Piping:

1. Copper tubing Type “L” ASTM B75, ASTM B88, ASTM B251, ASTM B 447. Lead-free soldered joints or mechanical joints.

B. Above Grade Drainage & Vent Piping:

1. Cast-iron soil piping with no-hub connections ASTM A74, ASTM A888.

C. Below Grade Drainage & Vent Piping:

1. Cast-iron soil pipe, hub & spigot fittings with neoprene gaskets. Compression type connections ASTM A74, ASTM A888.

D. Above Grade Storm Piping:

1. Cast-iron soil piping with no-hub connections ASTM A74.

E. Below Grade Storm Piping:

1. Cast-iron soil pipe, hub & spigot fittings with neoprene gaskets. Compression type connections ASTM A74, ASTM A888.

F. Above Grade Chemical Resistant Drainage Piping: (Acid Waste (AW) & Acid Vent (AV)

1. Pipe material to be Schedule 40 flame retardant propylene ASTM D2146. Mechanical joint fittings in standard DWV patterns only. Orion Blue line flame retardant or approved equal.

G. Natural Gas Piping Above Grade:

1. ½” thru 2” diameter-Pipe material shall be seamless or ERW black malleable iron, Schedule 40, ASTM A-53 Grade B. Malleable iron fittings and screwed connections.

2. 2 ½”-10” diameter-pipe material shall be seamless or ERW black malleable iron, Schedule 40 ASTM A53 Grade B. Provide ASME welded fittings & connections.
   a) All gas piping installed on the exterior and in boiler rooms/mechanical rooms, shall receive (1) prime coat and (2) finished coats of rust in habiting paint, color to be “safety yellow inside and on roofs” and “Gray outside at grade,” unless otherwise noted.

H. Compressed Air Piping:

1. Pipe material to be seamless or ERW black malleable iron. Schedule 40 ASTM A-53 Grade B, malleable iron fittings & screwed connections.

PART 3 - EXECUTION

3.01 EQUIPMENT AND SYSTEMS

A. All equipment and systems as shown on the drawings or specified herein shall be installed in accordance with the provisions of each applicable section of these Specifications and all local and state codes and regulations having jurisdiction.

B. All work shall be installed in a workmanlike manner as determined by Architects.

C. Accurately establish grade and elevation of all piping before setting sleeves. Install piping without springing or forcing (except where specifically called for), making proper allowance for expansion and anchoring. Arrange piping at equipment with necessary offsets, unions, flanges, valves, to allow for easy part removal and maintenance, as approved.

D. Offset piping and change elevation as required to coordinate with all other trades.

E. Avoid contact with any part of other mechanical or electrical systems.

F. Provide adequate means of draining and venting all units, risers, circuits and systems.

G. Conceal all piping unless otherwise specified.

H. Install piping and connections approximately as indicated or directed, straight, plumb, direct, parallel and close to building walls, partitions, ceiling, in general, with groups of pipes parallel to each other and close to structural members allowing for insulation and access for servicing valves, etc. Horizontal piping to be installed as high as possible without sags.

I. Coordination with other trades: Check Contract Drawings with all others, anticipate and avoid interference with other installations. Obtain decision or approval from Architect for proposed group installation and before proceeding, and for clearances in structure and finish.

J. Fixture branches exposed only as required for final connections.

K. Over Electrical Equipment: Prohibited. Special cases may be permitted with approval of Architect, protecting copper drip pan.

L. Ream pipes after cutting and clean before installing. Cap or plug equipment and pipe openings during construction. Install piping parallel with lines of building, properly spaced to provide clearance for insulation. Make all changes in direction and branch connections with approved fittings. All cleanout plugs, bushings and nipples, required for gauge and instrument installation shall be brass. Do not install valves, unions and flanges in inaccessible locations.

M. Materials used within a system and between systems shall be consistent. If this is not possible, install approved dielectric fittings.

3.02 HANGERS, INSERTS AND SUPPORTS

A. No piping shall be supported by wires, band iron, chains, or from other piping, nor by vertical expansion bolts. Support piping with individual hangers from concrete inserts, approved welded supports, or beam clamps of proper configuration and loading design requirements for each location; replace if not suitable. Follow manufacturer's safe loading recommendations. Always obtain approval.

B. Suspend with rods of sufficient length for swing and of size as previously scheduled, using four (4) nuts per rod. Use rods and nuts having electroplated zinc or cadmium (0.005" minimum) finish.

C. Provide additional approved structural steel members, having one coat rustproof paint, where required for proper support.

D. Provide oversized hangers where insulation/supports must pass between pipe and hanger.

E. Hangers, when attached to joists, shall only be placed at the top or bottom chord panel point. Only concentric type hangers are permissible; “C" type not permitted.

F. Riser Clamps: Provide riser clamps for each riser at each floor. Allow for escutcheon plates.

3.03 PIPE CONNECTIONS

A. Solder Connections: Use only 95/5 nonacid flux and clean off excess flux. Also remove excess solder from piping.

B. Threaded Connections: For steel pipe and brass pipe. Clean out tapering threads, made up with pipe dope; screwed until tight connection. Pipe dope must be approved for application.

C. Dielectric Pipe Fittings: Protect fittings from excessive heat.

3.04 SLEEVES

A. All underground pipes and conduits, regardless of their contents, shall be provided with sleeves at the foundation wall and shall be sealed at the section of entry into the building with a material that will form a gas-proof barrier.

B. Provide for all pipes passing through floors, walls or ceilings.

1. Standard type: Provide for all piping, except as specified above.

C. Extend l/8" above floor in all finished areas except those with floor drains or in Penthouse; use steel pipe sleeves 2" above floor in excepted areas. Use steel pipe sleeves in all bearing walls, structural slabs, beams and all other structural surfaces, and where specifically called for.

D. Sleeves, where installed in walls of shafts, shall be as small as practical, consistent with insulation, etc., so as to preserve fire rating of shaft walls.

E. Fill abandoned sleeves with concrete.

F. Where floors are membrane waterproofed, use flashing clamp device on sleeves equivalent to Josam Series 1880 "Riser Sleeve".

3.05 ESCUTCHEON PLATES

A. Provide polished chrome escutcheon plates for all exposed piping passing through floors, walls or ceilings, in all rooms except Mechanical Rooms.

B. Cut plates if necessary to fit conditions.

3.06 SLEEVE PACKING

A. Tightly seal void space at all sleeves throughout building as follows:

1. Interior locations: Firmly pack with fiberglass, the space between sleeve and pipe, then neatly caulk with caulking gun and approved material.
2. Exterior walls above grade: Use sealing element.
3. Exterior walls below grade: Use sealing element.
4. Cored holes: Method shall be approved or use sealing element.
5. Fire rated, partitions and floor slabs: Use fire rated sealing elements, materials and methods.
6. Waterproofed floors without membrane: Use Architects' approved sealing element, device or compound.
7. Waterproofed floors with membrane: Use Architects' approved sealing element, device or compound.

3.07 TESTS

A. Refer to Section 220010 for testing of plumbing systems.

3.08 PIPE LINE SIZING

A. Pipe sizes indicated on Contract Documents are to be maintained. Pipe size changes made only as approved by Engineer, or required by State or local codes.

B. Where discrepancy in size occurs, the larger size shall prevail, unless otherwise directed by the Architects.

3.09 TRAPEZE HANGERS

A. Use where groups of piping can be installed easily. Hangers are to be sized in accordance with loads imposed.

END OF SECTION

SECTION 221127 - WATER SUPPLY

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this section.

1.02 SUBMITTALS

A. All items specified under Part 2 - Products of this Section, including pipe and fittings.

PART 2 - PRODUCTS

2.01 WATER PIPING

A. Refer to Section 221116 - Piping Systems and Accessories; for acceptable materials.

2.02 DISINFECTION

A. The Contractor shall disinfect the entire hot and cold water system. This shall include all hot water circulation piping and connecting supply mains. Renovations to existing piping systems shall be isolated with new valves by Contractor for testing of new system only.

B. Use the purging and disinfecting procedure proscribed by the authority having jurisdiction or, in case a method is not prescribed by that authority, the procedure described in either AWWA C651, or AWWA C652, or as described below.

C. A chlorine solution shall be injected into and circulated through the entire hot and cold water system. Operate all hot and cold water faucets, flush valves, mixing valves and metering valves. Duct tape all metering valves to hold in on position. Continue flow of water from system until a determined uniform chlorine count of 50 ppm is reached. Then shut off all flow and let systems stand full.

D. Tube test samples of hot and cold water in each fixture area every 8 hours to determine chlorine residual content.

E. If the chlorine residual content drop is more than 10% in any 24 hour period, system must be injected with additional chlorine and Step A repeated. This shall continue until a 95% chlorine residual level remains over 24 hours.

F. After the system test has been accepted by the Architect or Engineer, the entire system shall be drained and refilled. It is important that if the building has a septic system all water must be drained on to paved areas of parking lots. The Contractor shall install all necessary valves at low points and furnish any pumps and drain piping to accomplish this.

G. Prior to final test, the system should be flushed through plumbing fixtures until any concentrated chlorine odor is undetectable.

H. A final test of both hot and cold water shall be taken at the furthest point of the system by a certified testing agency. Full bacteria and metals test shall be performed to verify the water meets all potable drinking water standards.

2.03 BACKFLOW PROTECTION

A. Provide where indicated (SEE SCHEDULE ON DRAWINGS AND BELOW)

B. BFP-1: Reduce Pressure Type (RPBP):

1. Approved for use by New York State Department of Health.
2. All bronze body construction (over 4" cast iron body), stainless steel bolts and stainless steel internal parts.
3. Easily removed from line for service.
4. Test cocks, strainer and isolation valves.
5. Provide drain assembly and full size drain line to nearest floor drain with air break.
6. Similar to Watts Series 909, Lawler RZ.
7. Contractor shall be responsible for all permits and tests as required by the Department of Health. This shall include disinfection of piping; see Section 220010.

PART 3 - EXECUTION

3.01 WATER SERVICE

A. Primary shut-off for water service entrance shall be:

1. Service size 2” and under shall be a full-port ball valve.
2. Service size 3” and over shall be a gate valve.
3. Butterfly valves shall not be used on the domestic water service.

3.02 WATER METER

A. Provide adequate straight run of pipe upstream of meter. Refer to manufacturer’s written installation requirements.

3.03 BACKFLOW PREVENTER

A. Mount above floor in accessible location. Minimum clearance above floor shall be 18".

3.04 PIPING

A. Run slightly off level to low points; provide drain valves.

B. Provide shock arrestors where shown, or specified.

C. Branch headers serving flush valves; full size as shown.

D. Provide dielectric pipe fittings when connecting to piping system of dissimilar metals.

E. Supply piping to all fixtures, faucets and flush valves shall be anchored to prevent movement.

F. Provide and install necessary wood or metal backing material to secure piping, flush valves, faucets, etc.

G. Piping shall be run to avoid all electrical panels and equipment.

END OF SECTION

SECTION 221130 - EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this section.

1.02 SUBMITTALS

A. All items specified in this Section under Part 2 - Products.

PART 2 - PRODUCTS

2.01 FLOOR DRAINS (SEE SCHEDULE ON DRAWING)

2.02 CLEANOUTS (SEE SCHEDULE ON DRAWING)

A. WCO: Zurn #Z-1446 cleanout with round stainless-steel wall access cover.

B. BCO: Zurn #1445 cleanout tee.

2.02 ACCESS DOORS

A. AD-1: Zurn ZANB-1462-VP square smooth nickel bronze wall access panel and frame 10"x10" with beveled edge and anchor lugs for over wall installation. Provide with vandal proof secured top.

2.03 WALL HYDRANTS (SEE SCHEDULE ON DRAWING)

2.03 HOSE BIBBS

A. Provide Watt's # HB-1 with built in vacuum breaker.

2.04 SHOCK ARRESTORS

A. Provide where shown on drawings and of size indicated.

B. Must meet or exceed requirements of the Plumbing and Drainage Institute Standard - PDI-WH 201.

C. Make: Watt's LF 15 MZ, male I.P.S. inlet.

2.05 THERMOMETERS

A. Provide where shown on drawings or called for in specifications. See Specification Section 220519 - Meters and Gauges, for requirements.

2.06 PRESSURE GAUGES

A. Provide where shown on drawings or called for in specifications, and where water service enters building. See Specification Section 220519 - Meters and Gauges, for requirements.

2.07 LINK SEALS

A. As manufactured by Thunderline Co. select style and links to suit type of piping to be sealed.

PART 3 - EXECUTION

3.01 WALL HYDRANTS

A. Install minimum 24" above grade.

3.02 SHOCK ARRESTORS

A. Install in vertical position and at accessible locations for maintenance.

3.03 CLEANOUTS

A. Install cleanouts out of traffic patterns; provide offset from unnecessary stress on basin at these points.

B. Do not locate under doors or under equipment, or behind cabinets.

3.04 ACCESS DOORS

A. Install access doors to provide access to shock arrestors. Coordinate location to avoid toilet partitions, grab bars, flush valves, etc. Install access doors flush and plumb with wall.

END OF SECTION

SECTION 224240 - PLUMBING FIXTURES AND TRIM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including the General and Supplementary Conditions and Division 1 Specifications Sections, apply to the work of this section.

1.02 QUALITY ASSURANCE

A. All fixtures and trim must be on the "approved" list of the New York State Department of Environmental Conservation.

B. The materials specified shall meet or exceed the applicable requirements of FSWW-P-541.

C. Each fixture and fitting shall be plainly and permanently marked with the manufacturer's name or trade mark.

1.03 SUBMITTALS

A. Product catalog cuts, manufacturer's specifications, roughing dimensions, installation instructions and maintenance data. Manufacturer shall furnish proof that fixture, faucet, valve, shower head, etc. is approved and meets latest New York State Department of Environmental Conservation Standards.

B. Maintenance Tools: Deliver to Owner's representative.

C. Keys for fixture stops.

1.04 MATERIALS (GENERAL)

A. Vitreous China: 1st quality, smooth, uniform color and texture and having a fused-on glaze covering on all exposed surfaces free from chips, craze, warpage, cracks and discoloration.

B. Porcelain Enameled Cast Iron or Steel: Smooth, uniform color and texture, having a fused-on glaze covering on all exposed surfaces. Material shall show no cracks, chips, craze or discolorations. Enameled surfaces shall be acid resistant.

C. All faucets, shut-off stops and supply risers must comply with ANSI 372 for lead free plumbing products.

D. All toilet seats shall be commercial grade heavy duty plastic.

PART 2 - PRODUCTS

2.01 WATER CLOSETS (SEE SCHEDULE ON DRAWING)

2.02 URINALS (SEE SCHEDULE ON DRAWING)

2.03 LAVATORIES (SEE SCHEDULE ON DRAWING)

2.04 SINKS (SEE SCHEDULE ON DRAWING)

PART 3 - EXECUTION

3.01 INSTALLATION

A. General:

1. Installation work of this section in strict accordance with the manufacturer's printed installation instructions and approved shop drawings.

2. Install fixtures level at heights indicated in specification; tighten all connections, install hold down bolts, cap nuts and cover plates where required.

3. Flush valves and wall faucets must be coordinated with ADA requirements for location and elevation. Secure with concealed fastening to assure that they cannot be pulled away from the wall surface.

B. Water Closets:

1. Locate handicapped flush valve handle on wide side of fixture.

2. Set bearing nuts to position the fixture 1/16" clear of the finished wall; caulk this space with white silicone based caulking sealant and strike a neat joint.

3. Install cap nuts and washers after all connections are tightened on floor mounted closets.

4. Caulk water closet at the floor line with white silicone based caulk.

C. Urinals:

1. Position fixture 1/16" clear of the finished wall; caulk this space with white silicone based caulking sealant and strike a neat joint.

D. Sinks:

1. Set faucets and strainer in bed of plumber's putty and tighten to fixture.
2. Caulk fixture with clear silicone based sealant at juncture of countertop.

E. Lavatories:

1. Set faucets and strainer in bed of plumber's putty and tighten to fixture.
2. Caulk countertop fixtures with clear silicone based sealant at juncture of countertop.
3. For wall mounted lavatories caulk with white silicone based sealant at junction to wall.
4. Set fixture level and plumb.

3.02 CLEANING FLUSHING AND ADJUSTMENT

A. Clean fixture and trim. Remove grease and dirt.

B. Flush supply piping and traps, clean strainers and aerators. Remove vandal proof aerator installation device.

C. Adjust stops, flush tanks and flush valves for proper delivery.

END OF SECTION

SECTION 226388 - INSTALLATION OF NATURAL GAS PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this section.

PART 2 - PRODUCTS

2.01 GENERAL

A. Refer to Section 221116 - Piping Systems and Accessories.

PART 3 - EXECUTION

3.01 GENERAL

A. Install natural gas distribution piping in accordance with applicable codes including NFPA-54, and local utility company requirements. Refer to Section 221116 - Piping Systems and Accessories.

B. Use sealants on metal gas piping threads which are chemically resistant to natural gas. Use sealants sparingly, and apply to only male threads or metal joints.

C. Remove cutting oil and threading burrs before assembling piping.

D. Do not install defective piping or fittings. Do not use pipe with threads which are chipped, stripped or damaged.

E. Plug each gas outlet, including valves, with threaded plug or cap immediately after installation and retain until continuing piping, or equipment connections are completed.

F. Install drip-legs in gas piping at all equipment connections, and where required by code or regulation.

G. Install "Tee" fitting with bottom outlet plugged or capped, at bottom of pipe risers.

H. Use dielectric unions where dissimilar metals are joined together.

I. Install piping with 1" drop in 60' pipe run (0.14%) in direction of flow.

J. Install piping parallel to other piping, but maintain minimum of 12" clearance between gas piping and steam or hot water piping above 200°F.

K. For piping buried in building substrate, or below floor slabs, install in welded conduit, ventilated to outdoors on both ends, and tested to same requirements as gas piping.

3.02 WELDING OF STEEL PIPING

A. All welding must be performed by a qualified Certified Welder in accordance with welding procedures according to Section 2 of API Standard 1104 or Section IX of the ASME Boiler and Pressure Vessel Code. Quality of welds shall be determined by destructive testing. Each welding procedure must be recorded in detail including results of the qualifying tests. This record must be retained and followed whenever the procedure is used.

3.03 INSTALLATION OF VALVES

A. Gas Cocks or Ball Valves: Provide at risers and branches where indicated.

B. Locate valves where easily accessible, and where they will be protected from possible injury.

3.04 EQUIPMENT CONNECTIONS

A. Connect gas piping to each gas-fired equipment item, with drip-leg and shut off gas cock. Comply with equipment manufacturer's instructions.

3.05 PIPING TESTS

A. Pressure Testing and Inspection - General:

1. Prior to acceptance and initial operation, all piping installations shall be inspected and tested to determine that the materials, design, fabrication and installation practices comply with Code Requirements.

2. Inspection shall consist of visual examination, during or after manufacture, fabrication, assembly or pressure tests as appropriate. Supplementary types of non-destructive inspection techniques, such as magnetic-particle, radiographic, ultrasonic, etc. shall not be required unless specifically listed herein or in the engineering design.

3. In the event repairs or additions are made following pressure test, the affected piping shall be tested, except that, in the case of minor repairs or additions, testing shall be permitted to be omitted where precautionary measures are taken to ensure sound construction.

4. Because it is sometimes necessary to divide a piping system into test sections and install test heads, connecting piping and other necessary appurtenances for testing, it is not required that the tie-in sections of pipe be pressure tested. Tie-in connections, however, shall be tested with soap solution after gas has been introduced and the pressure has been increased sufficiently to give some indications should leaks exist.

B. Test Medium: The test medium shall be air, nitrogen, or carbon dioxide. OXYGEN SHALL NEVER BE USED.

C. Test Preparation:

1. Pipe joints, including welds, shall be left exposed for examination during the test. If the pipe end joints have been previously tested in accordance with Code Requirements, they shall be permitted to be covered or concealed.

2. Equipment that is not to be included in the test shall be either disconnected from the piping or isolated by blanks, blind flanges, or caps. Flanged joints at which blinds are inserted to blank off other equipment during the test shall not be required to be tested.

3. Where the piping system is connected to equipment or components designed for operating pressures of less than the test pressure, such equipment or equipment components shall be isolated from the piping system by disconnecting them and capping the outlet(s).

D. Test Pressure:

1. Test pressure shall be measured with a manometer or with a pressure measuring device designed and calibrated to read, record, or indicate a pressure loss due to leakage during the pressure test period. The source of pressure shall be isolated before the pressure tests are made.

2. All gas piping shall be tested at a minimum of 15 psig for 1 hour. Where the test pressure exceeds 125 psig (862 kPa gauge), the test pressure shall not exceed a value that produces a hoop stress in the piping greater than 50 percent of the specified minimum yield strength of the pipe.

3. All underground gas piping shall be inspected and tested by local utility company. Any additional cost incurred shall be the responsibility of the Owner.

E. Detection of Leaks and Defects:

1. The piping system shall withstand the test pressure specified without showing any evidence of leakage or other defects. Any reduction of test pressures as indicated by pressure gauges shall be deemed to indicate the presence of a leak unless such reduction can be readily attributed to some other cause.

2. The leakage shall be located by means of an approved combustible gas detector, soap and water, or an equivalent non-flammable solution. Matches, candles, open flames, or other methods that could provide a source of ignition shall not be used.

3. CAUTION: Since some leak test solutions, including soap and water, may cause corrosion or stress cracking, the piping shall be rinsed with water after testing, unless it has been determined the leak test solution is noncorrosive.

4. Where leakage or other defects are located, the affected portion of the piping system shall be repaired or replaced and retested.

5. Test Records: Records shall be made of inspection and all tests performed. These records shall indicate which portions of the piping system conform to Code Requirements or were pressure tested.

F. Purging Procedure: The piping system shall be purged in accordance with NFPA 54.

3.06 SPARE PARTS

A. Furnish to Owner, with receipt, two (2) valve wrenches for each type of gas valve installed, requiring same.

END OF SECTION

DIVISION 23
HVAC SPECIFICATIONS (HC)
INDEX

SECTION 230005 - HVAC WORK GENERAL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all General Conditions, Supplementary Conditions, Division 1 specification sections as well as Information to Bidders requirements that are included in the project documents, apply to the work of this Contract.

1.02 ALLOWANCES, ALTERNATES AND UNIT PRICES

A. Refer to Division 1 specifications for allowances, alternates and unit prices required as part of this Contract.

1.03 INTENT

A. The intent of the drawings and these specifications is to provide all systems complete and operative. Whether indicated on the drawings and/or included in the specification or not, provide all materials, equipment and labor usually furnished with such systems.

1.04 DEFINITIONS

A. Provide: Furnish, install and connect.
B. Furnish: Supply material only.
C. EXR: Existing to remain.
D. MC: Mechanical Contractor-note MC and HC (Heating Contractor) shall be interchangeable for all drawings and specifications.

1.05 SCOPE OF WORK

A. This Contractor shall do all work, furnish all labor, tools and equipment necessary for all the HVAC work all as indicated on the drawings and specified herein.

1. Removal of existing equipment as indicated on drawings.

2. All cutting and patching.

3. Variable refrigerant system, complete with all accessories.

4. Air cooled condenser units; steel frames for units provided by steel fabricator.

5. Unit ventilators.

6. Fan coil units.

7. Cabinet unit heaters, complete with piping, controls, supports and accessories.

8. Fin tube radiation, complete with piping and accessories.

9. Unit heaters, complete with piping, supports and accessories.

10. Duct coils, complete with piping and installation accessories.

11. Exhaust fans, complete with accessories, curbs, etc., flashing by GC.

12. Pipe fittings, hangers, supports, valves and piping specialties as required to make complete heating system.

13. Refrigeration piping, fittings, valves, etc.

14. All diffusers, registers and grilles complete with accessories.

15. All louvers provided by Contractor.

16. Galvanized ductwork (or specialty ductwork where noted) to serve supply, relief and exhaust systems complete with control devices and accessories, unless otherwise noted.

17. Insulation both thermal and acoustical to serve piping, ductwork systems, equipment, housings and accessories.

18. Temperature control system complete to serve all HVAC equipment and systems complete with accessories.

19. Testing and balancing of all heating, ventilating and air conditioning installations to include sheetmetal ductwork, air conditioning supply and exhaust systems, heating and cooling systems and temperature control system. Balancing shall include NC ratings as described herein.

20. Special testing and balancing requirements for existing HVAC equipment to include repair of existing equipment as required to obtain air flow as indicated on drawings.

21. Servicing of heating, ventilating and air conditioning facilities are required for guarantee period. Provide competent factory trained men at site for purpose of instructing Owner's personnel in proper operation and maintenance of all new HVAC facilities.

22. Concrete pads, 4" high unless otherwise noted on drawings, to provide housekeeping elevation for boilers, pumps and such other equipment as shown on drawings that require a pad. Coordinate installation of pads with GC to insure secure bonding of pads to floor structure. This contractor shall be responsible for installation of pads.

23. Temporary heat as required by Architect's Special Conditions.

1.06 TEMPORARY SERVICES

A. Temporary Heat: In accordance with Architect's specifications and/or conditions, contractor shall have the permanent heating system capable of providing heat to the new work areas when required. The term heating system shall include all work or components necessary to operate heating system. For temporary usage, it is not required that this work be in a finished condition, i.e., covers in place, etc. Cost of fuel consumed for temporary heat from permanent systems only shall be paid by owner.

B. The use of permanent system will be allowed only if the building is fully enclosed with no construction dust to clog heating/cooling coils, heat recovery components, fans, etc.

C. At the completion of work, Contractor shall turn over to the Owner all equipment used for temporary heat in a <u>new</u>, <u>as purchased</u> condition. Contractor shall replace filters with new ones, clean all components which shall include: unit casings, ductwork, grilles, diffusers, etc., re-lubricate all moving parts, replace belts if required and perform any other work necessary (as determined by Architect and Engineer) to put equipment in a "new" condition.

D. Contractor shall take all measures necessary to insure that dust, dirt, or debris does not enter air systems while in operation for temporary heat and shall change filters as often as necessary. Under no circumstances shall air handlers be allowed to operate with no filter in place. All duct in the work area shall be sealed so no dust or debris will enter duct.

1.07 CONTINUITY OF UTILITY SERVICES

A. It is of paramount importance that each utility service operate continuously and without interruption. Whenever this contractor plans to make changes or alterations to any existing utility service, such plans shall result in no or minimum service interruption or inconvenience to Owner. This contractor shall plan and schedule any change or alteration to an existing utility service with Architect and Owner. Such planning, timing, and/or scheduling shall be approved by both these parties.

1.08 CODES AND STANDARDS

A. All materials, equipment, and installations by this contract shall be in accordance with the latest editions of the following applicable requirements:

1. 2020 New York State Building Code, including all applicable amendments supplements to the following:
   a) 2020 International Building Code
   b) 2020 International Existing Building Code
   c) 2020 International Fire Code
   d) 2020 International Plumbing Code
   e) 2020 International Mechanical Code
   f) 2020 International Fuel Gas Code

2. 2020 Supplement to the New York State Energy Conservation Construction Code, including all applicable amendments to the following:
   a) 2020 International Energy Conservation Code
   b) 2013 ASHRAE 90.1

3. 2020 Uniform Code Supplement (May 12, 2020)

4. New York State Department of Environmental Conservation.

5. Conform to requirements of NEMA.

6. Bear label of Underwriters Laboratories, Inc.

7. National Electrical Code NFPA Article 70, latest edition.

8. New York State Health Code.

9. Local Utility Standards.

10. Local Municipal and/or city standards.

11. ASHRAE Standard 15.

12. Conform with applicable requirements of ASTM - Regulations and Standards for Pipe and Pipe Fittings.

13. Be in accordance with USAS - Code for Pressure Piping, latest edition.

14. For external and internal duct insulations, have flame spread rating of 25 or less and smoke developed rating of 50 or less when tested in accordance with ASTM Standard E84.

15. Sheetmetal and Air Conditioning Contractor's National Association, Inc. (SMACNA), latest editions.

16. Conform with applicable requirements of Standard for the Installation of Air Conditioning and Ventilating Systems, NFPA 90A, and Code for Safety to Life from Fire in Buildings and Structures, NFPA 101.

17. Conform to requirements of ASHRAE 90.1, latest edition.

18. Be in accordance with design standards outlined in ASHRAE Handbooks, latest edition.

19. Conform to requirements of Owner's insurance carriers.

1.09 SUBMITTALS & SUBMISSION REQUIREMENTS

A. All submittals shall be in accordance with Division 1 requirements, the following requirements listed below, and also as indicated in each specification section. All submittals not complying with the listing above will be returned to the contractor without being reviewed. Rejection by Architect or Engineer of any items submitted shall require resubmittal of acceptable items.

1. Within (20) days after receiving notice to proceed, submit to Architect for review complete descriptive dimensional data and ratings for equipment and materials proposed to be furnished and installed.

2. All materials submitted shall clearly state the job name and specification section(s) that it applies to.

3. Any package containing more than one piece of equipment or material shall also contain a schedule clearly listing all items in submittal. Schedule page (s) shall also indicate project name and building name.

4. All submittals must be clearly marked using nomenclature used in this specification for proper item identification, schedule of usages, model numbers, construction materials, performance, data, etc.

5. Projects involving multiple buildings must have the submittals separated by building. Submittals in which buildings are combined will not be accepted. (Exception: When specifically approved by engineer, basic materials may be submitted once.)

6. The contractor shall insure that dimensions of equipment to be used conform to the space allocated for the equipment on the drawings.

7. Submittals traced or copied from contract drawings are not acceptable and will be returned without review.

8. In the event material and/or equipment is installed prior to obtaining approval of shop drawings, and in the sole opinion of the Owner's Agent, this material and/or equipment does not meet the specifications, the Contractor shall be liable for the removal and the replacement at no additional cost to the contract.

B. Samples: When requested by Engineer, provide samples of both specified equipment and proposed substitutions for review by the Owner's Agent. Such equipment shall be delivered to a location designated, or erected at the job site as directed. When neither is physically possible, arrange for the Owner's Agent to visit an acceptable site where the proposed equipment can be inspected.

C. Substitutions:

1. Submittals for equipment or materials other than as specified shall be accepted for review by the Owner's agent.

2. Approval of substitute equipment shall be based on functional, physical and aesthetic compatibility to the equipment specified as determined by the Owner's agent and approved by the engineer.

3. Where substitute equipment is approved, the contractor shall be responsible for, and bear the cost of any necessary changes by his trade or other trades to make the system complete and operable, including but not limited to any design fees and structural or steel changes required to implement a substituted unit.

4. Contractor is fully responsible for providing coordination between all trades affected by equipment substitution.

5. When requested, contractor shall submit layout drawings indicating new dimensions and arrangements of substituted equipment. Layout drawings shall indicate all revisions necessary for all services affected by substitution.

1.10 CUTTING AND PATCHING

A. This contractor shall bear the cost of all cutting and patching required by and for the installation of this work. This contractor shall perform all cutting and patching unless otherwise indicated on drawings or if directed by the Architect.

B. Patching of fire rated floors, walls, partitions, etc. shall be made using new materials equal to the fire rating of the existing.

C. Should changes, omissions or errors in this contractor's work require cutting, patching or making alterations in any portion of new construction, such work will be performed by GC at contractor's expense.

D. Cutting and patching of roof surfaces and structures shall only be performed by a qualified contractor, as approved by the Architect. The work of this contract shall bear the cost of above mentioned cutting and patching. This contractor shall insure that existing roof warranties remain in force.

E. This contractor shall furnish lintels, sized to accommodate structure above opening, where cutting and patching is to be performed on load bearing walls. Contractor shall obtain written approval for all lintels prior to installation.

F. Cutting shall be done in a manner which will not adversely affect the strength of the building. Holes and openings shall be neatly cut so as to provide a finished appearance and shall be patched around the edge where required for a finished appearance. Provide temporary bracing, shoring, etc. as required.

G. Patching shall be structurally sound and match the existing materials and finish of adjacent materials. Patching is required in finished areas, wherever existing work is removed, at the sides of openings, etc.

H. At the completion of the work, all evidence of alteration will be as inconspicuous as possible.

1.11 FIELD INSPECTION

A. As there are various conditions at the site which do not show on the accompanying drawings, or which are at variance with the conditions indicated on the drawings, it is important that each bidder visit the site and acquaint himself with existing conditions, and take these conditions into consideration when preparing his proposal. Each bidder shall obtain information or make any measurement desired. Lack of knowledge relative to existing conditions will not be allowed as a basis for extra compensation.

B. This contractor and his subcontractors shall inspect existing equipment to remain prior to any of his new work in order to determine that all equipment is in good operating condition. If equipment is found to be lacking components, is inoperable, damaged, etc., contractor shall provide immediate written notice to the Owner. The Owner or his representative shall determine if any additional work is necessary and the method by which any work shall be performed.

1.12 INSTRUCTION SERVICES AND MANUALS

A. Instructions:

1. Provide competent personnel to remain at the jobsite for necessary time to instruct the Owner's personnel in proper operation and maintenance of installation made by this contractor.

2. This contractor shall be responsible for notifying and instructing Owner's personnel on all equipment operations, maintenance requirements, etc. Furnish operating training session(s) for equipment listed.

3. The Owner shall be responsible for establishing an operating and maintenance program for all equipment listed.

B. Training Session: A training session shall be held for each system and/or item listed below: (Note: For Temperature Controls refer to Temperature Control Sections for training requirements.)

Item	Description	Training Hours For Each Bldg
1.	Fan coil units	4
2.	Unit vents	4
3.	Variable refrigerant systems	8

C. The instruction shall include the following types of information:

1. System overview
2. Major component designation
3. System operation procedures
4. Maintenance scheduling and procedures
5. Provide a list of spare components each system would normally require

D. Services: Provide services required, for all equipment specified under this contract, for a period of (1) year after written acceptance by the Owner.

E. Manuals: Submit (3) sets of Operation and Maintenance manuals. Each set shall contain the manufacturers' data, operating instruction parts catalog and maintenance procedures for each piece of equipment. Include normal maintenance servicing schedule to be performed by the Owner.

1. For projects containing multiple buildings, manuals shall be submitted separately for each building.

1.13 PERMITS, CERTIFICATES AND FEES

A. This Contractor shall obtain and pay for permits, certificates, fees etc. listed below and as required. Costs for permits, fees etc. shall be included in the base bid amount.

1. All required applications and permits to begin work
2. Certificate of inspection including Third-Party Agency.
3. All municipal connection charges
4. All local utility charges (power, telephone, cable, etc.)
5. Fees and charges shall be obtained directly from the respective authority having jurisdiction
6. Fees and charges for hazardous waste hauling as required by DOT, DEC, etc.

1.14 REMOVAL, DISPOSAL AND HAZARDOUS MATERIALS

A. All removed equipment shall be removed from the site and properly disposed of.

B. All hazardous materials must be disposed of in compliance with ENCON and all other regulatory agencies. The contractor shall provide the owner with written chain of custody reports and final destination of disposal.

C. The Owner may wish to keep certain equipment, therefore, check with Owner before removals to determine what may be salvageable.

D. Unless otherwise noted, all equipment to be removed shall have all accessories and supports removed with it, whether indicated or not. In addition, any refrigeration containing equipment that is shown for removal shall have all refrigerant evacuated from the system and properly disposed of and all refrigerant piping removed from the site.

E. Any equipment, piping or ductwork that has been removed in the project and has left an opening and/or anchor points in a floor, wall or roof shall have the openings and voids infilled to match existing conditions.

1.15 GUARANTEE

A. Contractor shall guarantee all work furnished through this contract including work performed by sub-contractors, for a period of (1) year (unless otherwise noted), from the date of final acceptance. Contractor agrees to repair or replace any defective work or materials at no additional cost to the Owner. Contractor shall also pay for any damage to other work resulting from repairs to defects. Contractor shall furnish written guarantees to the Owner's agent in accordance with the general conditions.

1.16 INSTALLATION

A. This contractor shall coordinate scheduling and installation of work with other contractors, sub-contractors and other trades. The contractor is also required to coordinate all work with owner supplied materials, direct contracts, and normal building operations, if any.

B. All finished work shall be neat and workmanlike. All work of a special nature shall be performed by skilled and qualified workmen who can present credentials showing experience in said trade. New systems shall be delivered to Owner complete in perfect working order, tested and balanced in full accordance with plans and specifications. Existing systems shall function in same manner as before this work was performed. Any malfunctions which arise in existing systems as a result of demolition or alteration of parts of such systems shall be corrected.

C. Layout of equipment, accessories and piping systems in plan is generally diagrammatic unless specifically dimensioned or detailed. Check project drawings and existing site conditions before installing work for interference's as governed by structural or other conditions. Owner reserves the right to make reasonable changes in location of equipment, accessories or piping systems prior to "roughing-in" without involving additional expense. Exact dimensions shown upon plans will be subject to verification and confirmation of exact conditions at site at time of construction. "Plus or minus" dimensions are shown upon drawing as a guide only. Exact surrounding conditions are governed by final equipment selection and/or other like details.

D. Furnish all new equipment and materials as described herein. Any material, operation, method or device mentioned, listed or noted within this specification, if not specifically mentioned as furnished or installed by others, shall be furnished and installed by this contractor.

1.17 STORAGE OF MATERIALS

A. For all ductwork, piping and insulation brought to the jobsite, it shall be protected from all environmental elements. This shall include, but not limited to, water, dust, chemicals and other hazardous materials. It shall be stored within a protected area in the building.

B. All ductwork onsite shall have a wrap on it to prevent the duct from having any dust, debris or other hazardous materials from becoming adhered to the interior of the duct. No duct may be stored where it could be rained on. Also refer to section 233330, low velocity ductwork, for additional information.

C. All insulation on the jobsite will be stored in an area that will protect it from weather damage.

1.18 START UP

A. A start up shall be performed for all new HVAC equipment (HVAC equipment shall be defined as any HVAC unit that requires power or a temperature controls connection). The manufacturers representative will be onsite and unit operation will be verified, including but not limited to air flow, heating and cooling setpoints are attained and unit functions within manufacturers parameters. A written report shall be furnished to the architect.

1.19 TESTING AND INSPECTION

A. Inspections required for any ordinances, regulations, instructions, laws, rules, standards and practices that require any work to be inspected or tested shall be performed. Contractor shall give Owner, Architect and Engineer timely notice of readiness of work for inspection or testing and the date fixed for said inspection or testing.

B. Third-Party Agency must inspect completed installation and present Owner with Certificate of Inspection showing approval.

C. Required local or municipal inspection processed and present Owner with certificate indicating approval of such governing bodies.

D. Contractor shall submit a written report to Architect, copy to Engineer, on results of each inspection or test on system or equipment supplied. Report shall contain all pertinent information, recommendations, approvals, additional work required, etc.

1.20 RECORD DOCUMENTS

A. When required by general conditions or other Division 1 Section, this Contractor shall prepare and turn over to Owner's agent record As-built documents. As-built drawings will include actual equipment location layout, service connections, ductwork and piping layouts, valve locations, etc.

B. In all projects, contractor shall provide record drawings of all underground equipment and service runs. As-built drawings for underground work will include dimensions to actual locations finish grade elevations, and actual invert to underground structures equipment and service runs.

1.21 IDENTIFICATION AND NAMEPLATES

A. Provide engraved plastic labels screwed to all HVAC equipment furnished under this contract including but not limited to: pumps, air handling units, rooftop units, exhaust fans, condensing units, control panels, starters, switches, panels, etc. Labels shall have black background, white letters; minimum letter height 3/8" high, self adhesive labels or punch tape type labels are not acceptable.

1.22 PENETRATIONS THRU FIRE RATED CONSTRUCTION

A. All penetrations by this contract through rated construction shall be sealed fire safe by a UL listed approved method.

B. All piping penetrations through walls, floors, etc. shall be sleeved.

C. All ductwork penetrations shall be furnished with trim frames.

D. All piping and ductwork penetrations through fire rated partitions, walls, floors, etc. shall be installed as follows; penetration shall be oversized 1/2" to 3/4" maximum. This contractor shall pack with fireproofing insulation, type FS cerablanket. Outside of penetrations (exposed surfaces around pipes and ductwork) shall be caulked and sealed with flame stop V, as manufactured by Flame Stop, Inc.; or an approved equal. Flame stop sealant shall be troweled smooth for finishing as required.

1.23 CONFINED SPACES

A. All work in pipe tunnels, mechanical pits, well manholes, etc. shall be performed by skilled tradesman and laborers with current certification for working in confined space. Contractor shall bear all costs to provide all safety equipment, ventilation, etc. as required by State and Federal Regulations and shall obtain all necessary permits for such work.

B. Contractor shall submit copy of current certifications and photo I.D. of all tradesman and laborers who will be working in confined spaces on this project.

1.24 COORDINATION

A. Layouts of duct and piping systems shown on contract drawings are diagrammatic. Actual duct and piping layouts shall be coordinated in the field by the contractor. Ductwork shop drawings shall be submitted for approval (see next section for coordination drawings if applicable). Coordinate with other trades and with existing conditions, as required for proper installation of all systems. Contractor shall verify that ductwork and piping layouts are coordinated with all other construction trades which might cause a conflict. Any changes due to systems not being properly coordinated shall be the contractor’s responsibility.

B. All offsets, elbows, duct/pipe transitions, air vents, drains and accessories required to accommodate field changes found during coordination drawings are the responsibility of the contractor at NO additional cost.

C. NOTE: Ductwork and piping drawings will NOT be given to the contractor since it is expected of the contractor to field verify and draw the ductwork and piping.

D. Refer to section 013100 Project management and coordination for obtaining cad files from the architect.

E. All offsets, elbows, duct/pipe transitions, air vents, drains and accessories required to accommodate field changes found during shop drawings are the responsibility of the contractor at NO additional cost.

1.25 COORDINATION DRAWINGS

A. Before construction work commences, Contractors for all trades shall submit Coordination Drawings at not less than 1/4" = 1'-0" scale. These drawings shall identify and show elevations of all trades and resolutions of trade conflicts. Mechanical Equipment Rooms shall be drawn early in the Coordination Drawing process, simultaneous with all other congested areas.

B. Prepare three-dimensional component conflict analysis (building information modeling - BIM) as part of coordination drawings. Refer to section 013100 Project management and coordination for obtaining revit models from the architect (if available). Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Architect.

C. Contractor shall perform the final coordination review. As each coordination drawing is completed, Contractor will meet with Architect to review and resolve conflicts on the coordination drawings.

D. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.

E. Show location and size of access doors required for access to concealed dampers, valves, and other controls.

F. Indicate dimensions shown on drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternative sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

G. Additional design, drafting and/or engineering time to fully complete the coordination drawings shall not be considered an additional cost to the project and shall be part of the contract.

H. Show the sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.

I. Architect will review coordination drawings to confirm that, in general, the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Architect determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Architect will so inform Contractor, who shall make suitable modifications and resubmit.

J. Coordination drawings shall be required for all boiler rooms and mechanical rooms.

K. Prepare Coordination Drawings as follows:

1. Coordination drawings shall be required in the following areas:
   a) HS – all rooms drawing MP 301.

L. HVAC Contractor will prepare the base plan Coordination Drawings showing the building, all ductwork and all pertinent piping and equipment. The drawings shall be coordinated with cable tray, lighting fixtures, sprinklers, air diffusers, other ceiling mounted items, ceiling heights, structural work, maintenance clearances, electric code clearance, reflected ceiling plans, and other contract requirements. Reposition proposed locations of work after coordination drawing review by the owner and the architect. Provide adjustments to exact size, location and offsets of ducts, pipes, conduit, etc., to achieve reasonable appearance objectives. Provide these adjustments as part of Base Bid Contracts. Minor revisions need not be redrawn.

M. HVAC Contractor will provide prints and CAD drawings and submit the base plan to all major trades' Contractors.

N. Electrical, Plumbing and Fire Protection Contractors will draft location of piping and equipment on the base plan, indicating areas of conflict and suggested resolutions.

O. All offsets, elbows, duct/pipe transitions, air vents, drains and accessories required to accommodate field changes found during coordination drawings are the responsibility of the contractor at NO additional cost.

P. Coordination meetings will be held as necessary as determined by the architect.

END OF SECTION

SECTION 230523 - PIPING SYSTEM VALVES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections apply to work in this section.

1.02 SUBMITTALS

A. Schedule of valves and service.
B. Product data for all valves.

1.03 REFERENCE STANDARDS AND CODES

A. All installations and materials shall conform to applicable 2020 New York State Building Code, and local building and plumbing codes.

B. All installations shall conform to requirements of Owner's Insurance carriers.

C. Refer to the latest edition and applicable sections of the following:

1. Underwriters Laboratories (UL)
2. American Society of Testing and Materials (ASTM)
3. American National Standards Institute (ANSI)
4. American Society of Mechanical Engineering (ASME)
5. Code for Pressure Piping B31.9 - Building Services Piping
6. American Welding Society (AWS)
7. National Fire Protection Association (NFPA)
8. Manufacturer's Standardization Society of the Valve and Fitting Industry (MSS)

1.04 GENERAL REQUIREMENTS

A. Ensure valves are dry and internally protected against rust and corrosion. Store valves indoors. Maintain valve temperature higher than the ambient dew point temperature. If outdoor storage is necessary, support valves off the ground or pavement in watertight enclosures.

B. Protect valve ends against damage to threads, flange faces and weld-end preps.

C. Do not use hand-wheels and stems as lifting or rigging points.

D. All valves shall be same size as upstream piping, unless otherwise indicated.

E. Furnish valves with pressure and temperature ratings as specified and required to suit system pressures and temperatures.

F. Furnish valves with either threaded, flanged or solder-joint end connections as specified.

G. Furnish chain wheel operators for valves 6" and larger when valve is to be mounted 8' or higher above finished floor elevations.

PART 2 - PRODUCTS

2.01 VALVE SCHEDULE

A. Note: Specialty valves specified in other sections.

	Pipe Fill	Pipe Size	Valve Type
1.	Heating Hot Water	Up to 2"	BV-1
2.	Heating Hot Water	2-1/2" & Over	WV-1
3.	Heating Hot Water	Up to 2"	CBV-1
4.	Heating Hot Water	2-1/2" & Over	CBV-2
5.	Heating Hot Water	Up to 2"	CKV-1
6.	Heating Hot Water	2-1/2" & Over	CKV-2
7.	Steam (30 psig & above)	Up to 2"	GV-3
8.	Steam (below 30 psig)	Up to 2"	GV-1
9.	Steam Condensate	Up to 2"	BV-1
10.	Steam Condensate	2-1/2" & Over	WV-2
11.	Condensate Drain	Up to 2"	BV-1
12.	Condensate Drain	2-1/2" & Over	WV-1

B. Valve Types

1. BV-1: Ball valve, size as required, sweat or threaded ends, forged bronze body, hard chrome plated ball, glass reinforced durafill seats, PTFE stem packing, 600 psi WOG non-shock, 150psi WSP for ¼”-2”, 450°F (@50psi) maximum temperature. Brass body is not acceptable and will be rejected. Series #B6000, B6001, Watts Regulator Co.; or equal.

2. CBV-1: Circuit balancing valve, size as required for nominal 2 ft WG pressure drop. Y-pattern Style design and all metal parts of nonferrous, pressure die cast, nonporous Ametal copper alloy and high strength resin hand-wheel and sleeve. Provides a positive shut-off. Provision for connecting a portable differential pressure meter. Each meter connection shall have pressure/ temperature readout ports. Rubber O-ring disc to ensure positive shut-off. Valve shall provide multi-turn, 360° adjustment, digital handwheel with hidden memory feature to set the valve with precision tamper-proof setting. Model STAD, rated at 300 psig, 250°F, TA Hydronics; or equal.

3. CBV-2: Circuit balancing valve, size as required for nominal 2 ft WG pressure drop. Flanged, Y-pattern Style design with ductile iron body and other metal parts of nonferrous copper alloy and high strength resin hand-wheel and sleeve. Provides a positive shut-off. Provision for connecting a portable differential pressure meter. Each meter connection shall have pressure/ temperature readout ports. Rubber O-ring disc to ensure positive shut-off. Valve shall provide multi-turn, 360° adjustment, digital handwheel with hidden memory feature to set the valve with precision tamper-proof setting. Model STAF, rated at 250 psig, 250°F, TA Hydronics; or equal.

4. CKV-1: Check valve, bronze body, bronze disc. rated at 200 psi, non-shock for 2" and smaller. Nibco Model #T-413; or equal.

5. CKV-2: Check valve, iron body, bronze disc. rated at 200 psi, non-shock, flanged connections for 2-1/2" and larger. Nibco Model #F-918; or equal.

6. FCV-1: **ADJUSTABLE** Automatic flow control valves. Valve gpm shall be factory set and shall automatically limit flow to within 5% of specified rate. For 3/4" to 2" valves flow cartridge shall be removable from valve housing without the use of special tools to provide access without breaking main piping. Cartridge flow rates shall be externally adjustable while system is in operation with 41 flow rate settings

range per cartridge. A true design operating pressure (psid) range of 4.4 – 58 psi is required. Each valve should have 2 P/T ports. All automatic flow control valves shall be provided by single source with certified flow tests. Internal wear surfaces of the valve cartridge shall be stainless steel. The cartridge body shall have machined threads to compensate for the spring free height. Fixed shims are not acceptable. Cartridges shall be color coded to determine model type and GPM Range and a flow rate chart for external adjustment of flow rate settings shall be provided. For 3/4" to 2" valves, valve assembly shall consist of Y type body and O-ring union. 2-1/2" to 6" valves shall be flanged wafer style valves and shall be externally adjustable while system is in operation with 51 flow rate settings per valve insert. Static pressure rating of 580 psi with a temperature rating of 248 F. Valve shall be E-just, by FlowCon International.; B&G; or approved equal. **NOTE: It is the intent that an externally adjustable valve is used to simplify installation, so the balancer can set the flow and ensure that the correct flow is achieved.**

7. GV-1: Gate valve, size as required, Class 125, bronze body, solid wedge, traveling stem threaded ends, rated for steam, rated at 200 psig and 353 F, T-113, Nibco; or equal.

8. GV-3: Gate valve, size as required, Class 200, bronze body, monel seats, bronze wedge, rising stem, threaded ends, Figure #B-144, Stockham Valve Co.; or equal.

9. ROM-1: Provide a portable computerized balancing instrument capable of indicating pressure differential and temperature measurement across a system component. Instrument to contain a micro computer and a sensor unit with pressure sensor, measurement valve and connections. TA Hydronics Model TA CBI: or approved equal. Contractor shall provide (1) unit per project and turn over to Owner at project completion.

10. WV-1: Butterfly valve (HW) 2” – 12” size as required,. One piece cast iron **LUG** style body ANSI class 125/150, extended neck, Stainless Steel disc with polished edges, one piece stainless steel stem, triple function molded-in EPDM seat, upper and lower stem bearings, NBR (Buna) upper stem seal, bubble-tight shutoff, temperature range of -20o F to 250o F, pressure rating of 250 psi bi-directional. Keystone Figure 222; or equal.
    a) Grooved end valve: 300 psi CWP suitable for bidirectional and dead-end service at full rated pressure. Body shall be grooved end black enamel coated ductile iron conforming to ASTM A536. Disc shall be electroless nickel plated ductile iron with blowout proof 416 stainless steel stem. Disc shall be offset from the stem centerline to allow full 360 degree seating. Seat shall be pressure responsive EPDM. Valve shall be complete with ISO flange for actuation mounting. Valve operators shall be lever handle or gear operator, available with memory stop feature, locking device, chainwheel, or supplied bare. Basis of Deign: Victaulic S/761

PART 3 - EXECUTION

3.01 GENERAL

A. Install all valves per manufacturers recommendations.

END OF SECTION

SECTION 230593 - TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary conditions and Division 1 Specification Sections, apply to work of this section.

1.02 SUBMITTALS:

A. Description of intended testing procedures.
B. Blank data forms indicating all intended test data points.
C. Written statement of coordination with sheetmetal contractor.
D. Written statement of coordination with piping contractor.
E. Written statement of acceptance of location and quantity of air and water balancing devices.
F. Pre-balance information from existing systems, where required.

1.03 QUALIFICATIONS

A. Acceptable Subcontractors are:

1. Member contractors of "Associated Air Balance Council".
2. Member contractors of "National Environmental Balancing Bureau".

B. Procedures and Methods: Follow written procedures published, one or more of following:

1. Associated Air Balance Council (AABC).
2. National Environmental Balancing Bureau (NEBB).

1.04 SCOPE OF WORK

A. Contractor shall perform testing, balancing and adjusting work on all new and existing equipment shown on plans, listed in this section and as required by applicable sections of the specification. Note: All existing equipment used in new or renovated systems is required to be tested adjusted and balanced.

B. Note: Air side systems shall be balanced prior to water balance.

C. Testing, adjusting and balancing is required for all of the following:

1. Air Side Equipment:
   a) Air Handling Units
   b) Supply, Return, Exhaust and Relief Duct Systems
   c) Terminal Equipment
   d) Diffusers, Registers and Grilles

2. Hydronic Equipment:
   a) Pumps
   b) Air Handling Unit Coils
   c) Terminal Equipment Coils
   d) Piping Distribution Systems
   e) Terminal Radiation Units

1.05 GENERAL REQUIREMENTS

A. It shall be responsibility of the Contractor to place all systems in satisfactory operating condition, including providing services of approved adjusting and balancing subcontractor regularly engaged in this type of work.

B. Furnish set of Bid Documents to subcontractor within ten (10) days after award of contract.

C. Adjusting and balancing shall be accomplished as soon as possible after systems are complete and before Owner takes possession.

D. All systems must conform with the following noise criteria:

1. Areas shall have NC30 to 35.

E. Initial adjustment and balancing to quantities indicated on design drawings and thereafter as required to satisfy job conditions to satisfaction of the Architects.

F. Adjusting and balancing shall be accomplished under appropriate outdoor temperature conditions.

G. Immediately prior to subcontractor's arrival on project:

1. Adjust all balancing cocks and dampers open.
2. Place all equipment in operating condition.
3. Clean all strainers.
4. Remove all temporary air filters and install design filters.

H. During course of the adjusting and balancing work:

I. Maintain qualified personnel at project at all times for system operation, trouble shooting, assistance, etc.

J. Change pulleys and belts as required to meet system performance requirements. Adjustable sheaves shall not be operated at extreme end of adjustment. Replace adjustable sheaves with proper size to operate approximately in mid-range.

K. Perform necessary mechanical adjustments in conjunction with balancing procedure.

L. Replace all flow balancers in new and existing systems that cannot be manipulated to satisfy balancing requirements.

1.06 JOB VISIT

A. Balancing subcontractor shall visit job prior to concealment of work and advise location of dampers, test connections, etc.; advise Architects by letter.

B. Make any changes or additions of types, locations, etc. of balancing facilities.

1.07 FINAL REPORT

A. Upon completion, all information shall be inserted in report form listing all items required by specifications. Entire report shall be typewritten and shall be submitted to Architect and Engineer for approval. Results shall be guaranteed. Provide (3) hard copies and electronically submit to architect.

B. Complete balancing analysis on all individual equipment and systems as specified shall be included in report.

C. Contractor shall be subject to recall to site to verify report information before approval of report by Architects.

D. Record action taken to adjust all systems to meet design specifications.

E. Report on condition of installations (i.e. - complete/inoperative etc.)

F. Final reports which do not contain all data required by this section will be rejected. Contractor will be required to retest and resubmit for all applicable systems with missing information.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Provide all tools, ladders, recording meters, gauges, thermometers, velometers, anemometers, Pitot tubes, inclined gauge manometers, magnehelic gauges, amprobes, voltmeters, psychrometers, tachometers, etc. required to execute the work. Instruments used shall be accurately calibrated.

1. NOTE: IF VFD IS PROVIDED, CONTRACTOR SHALL USE VFD FOR BALANCING OF AIR OR HYDRONIC EQUIPMENT. SYSTEM TO BE BALANCED WITH TDV COMPLETELY OPEN.

PART 3 - EXECUTION

3.01 AIR AND HYDRONIC SYSTEMS

A. Preparation:

1. Examine bid documents and notify Architects of any questions regarding balancing, within 30 days after receipt of bid.

2. The balancing subcontractor shall review sheetmetal shop drawings and mark the location of all required balancing dampers before duct fabrication.

3. Written notice of coordination between Contractor and balancing contractor to be submitted to Architect and Engineer.

B. Requirements for Air-Side Testing, Adjusting & Balancing:

1. Air Handling Equipment:
   a) Record all drive information (i.e. - sheave type, belt size, motor data).

   b) Test and adjust fan rpm to design requirements.

   c) Record RPM and final sheave position.

   d) Test and record motor no load, and full load amperes, and determine operating brake horsepower.

   e) Test and record inlet and discharge static pressures.

   f) Test, adjust and record SA, RA, OA and relief air flows for design recirculated air cfm.

   g) Test, adjust and record SA, RA, OA and relief air flows for full design outside air cfm. Make special effort to test and record total relief cfm air.

h) Test and record entering and leaving air temperatures. (D.B. heating and cooling)

i) Test and record equipment sound levels in closest occupied space.

2. Ductwork & Air Distribution Systems:
   a) Adjust all main supply, exhaust and return air ducts to proper design cfm, supply, exhaust, return and relief.

   b) Test and adjust each diffuser, grille, and register to within 10% of design requirements.

   c) After grilles, diffusers and registers are set at final CFM, check and record sound levels at occupant level at all locations.

   d) Each grille, diffuser, and register shall be identified as to location and area.

   e) Size, type and manufacturer of diffusers, grilles and registers, and all tested equipment shall be identified and listed; manufacturer's ratings on all equipment shall be used to make required calculations.

   f) Readings and tests of diffusers, grilles and registers shall include required fpm velocity and test resultant velocity, required cfm and test resultant cfm after adjustments.

3. Terminal Units:
   a) Adjust terminal units to cfm.

4. Fans (Supply & Exhaust):
   a) Record all drive information (i.e. - sheave type, belts, size, motor data).

   b) Test and adjust fan rpm to design requirements.

   c) Record cfm, rpm and final sheave position.

   d) Test and record motor no load and full load amperes and determine operating brake horsepower.

   e) Test and record inlet and discharge static pressures.

   f) In cooperation with control manufacturer's representative, make mechanical adjustments of automatically operated dampers to operate as specified, indicated, and/or noted; subcontractor shall check these damper control operations for proper calibrations and list those requiring adjustment by control installers.

   g) All diffusers, grilles and registers shall have air patterns adjusted to minimize drafts in all areas.

   h) A record of all final settings shall be made, preferably at each piece of equipment by an appropriate approved mark or if necessary by description on the report schedule.

   i) Record all space temperatures. If space temperatures vary more than 2°F from thermostat setting readjust air flows to obtain proper temperature.

C. Requirements for Water Systems Testing, Adjusting & Balancing:

1. Initial Procedure:
   a) Examine bid documents and notify Architects of any questions regarding balancing, within 30 days after receipt of bids.

   b) Air systems shall be examined first.

   c) Open all manual valves to full open position; close coil bypass stop valves; set automatic control valves to full coil flow.

   d) Examine water in system and determine if water has been treated and cleaned.

   e) Check expansion tank and/or compression tanks to determine if they are not air bound or water logged and system is full of water and a proper minimum fill pressure.

   f) Check all air vents at high points of water systems and determine if they are installed and operating freely.

   g) Balance terminal units furthest from pumps, work towards pumps. Final balance pump flow control valve(s) last.

2. Piping Distribution System:
   a) Test and adjust all flow control devices.

   b) Record final settings and distribution gpm.

   c) Test and record pressure on non adjustable flow control valves. Verify pressure is within control range on valve.

3. Hydronic Coils (HW):
   a) Set all temperature controls so all coils are calling for full flow.

   b) After adjustments to coils are made, recheck settings at pumps and readjust as required.

   c) Read pressure and differential across coils and set flow rate on coil for full heating; set pressure drop across bypass valve to match coil full flow pressure drop.

   d) Record and check the following items at each heating element:
      (1) Inlet water temperature.
      (2) Leaving water temperatures.
      (3) Pressure drop.

   e) Check water temperatures at outlet side of heating coils; Note: drop of temperature from source.

   f) Upon completion of flow reading and adjustment of coils, mark all settings and record data. Show on schematic sketch form wherever practical.

4. Fin Tube Radiation:
   a) Test, adjust and record gpm for fin tube unit.

   b) For units not equipped with balancing valve, adjust flow across fin tube using temperature drop method.

c) Record flows or temperature drop readings and flow calculations.

3.02 STEAM SYSTEMS

A. Preparation:

1. Examine bid documents and notify Architects of any questions regarding balancing, within 30 days after receipt of bids.

2. Air systems shall be balanced first.

B. Initial Procedure:

1. Open all manual valves to full open position; close coil bypass stop valves; set automatic control valves to full coil flow. Examine steam in system and determine if desired flow is attainable.

2. Set all temperature controls so all coils are calling for full flow.

3. Check operation of any automatic bypass or diverting valves.

4. Check all steam traps and determine they are installed and operating freely.

C. Flow Adjustments:

1. Check steam temperatures at outlet side of heating coils; Note: drop of temperature from source.

2. Upon completion of readings and adjustment at coils, mark all settings and record data. Show on schematic sketch form wherever practical.

3. Fin radiation balancing valves shall be set by temperature drop across the fin. Drop shall be consistent with drop and heat output as specified herein.

D. Final Check:

1. After procedure is complete, thoroughly clean all strainers, dirt pockets, traps, etc.

END OF SECTION

SECTION 230713 - DUCTWORK INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.02 WORK INCLUDED

A. Insulate all ducts and as required by contract documents.

1.03 REFERENCES

A. Test standards and reports for evaluating and rating performance of fire rated shaft enclosures and zero inch clearance ratings for duct wrap systems for compliance to Code.

1. ISO 6944-1985, ‘Fire Resistive Tests - Ventilation Ducts’.

2. ASTM E 2336, ‘Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems’.

3. ASTM E 814 (UL1479), ‘Fire Tests of Through-Penetration Fire Stops Standard’.

4. ASTM E 84, ‘Standard Test Method for Surface Burning Characteristics of Building Materials’.

5. ASTM C 1338, ‘Fungi Resistance of Insulation Materials and Facings Standard’.

6. NFPA 96 ‘Standard for Ventilation Control & Fire Protection of Commercial Cooking Operations’.

1.04 SUBMITTALS

A. Manufacturer data for all materials used in contract. Submit schedule of insulation applications.

PART 2 - PRODUCTS

2.01 DUCTWORK INSULATION

A. NOTE: IF A CONDITION IS NOT LISTED BELOW, IT SHALL BE INSULATED WITH 2" RB.

B. All exhaust fan and relief hoods shall have the void between the duct and the curb completely insulated with FB insulation.

C. The following is a schedule for ductwork insulation:

	Duct System & Location	Type	Thickness	Notes
1.	Outside Air, Relief Air, and Exhaust Air Ducts & Plenum Exposed to Air at Outside Ambient Temperatures (For All Air Handling and Energy Recovery Units), Energy Recovery Exhaust:			
	a) Concealed Spaces	FB	3"	(2)
	b) Exposed Spaces	RB	2"	(1)
2.	Supply & Return Duct:			
	a) Concealed Spaces	FB	2"	(2)(4)
	b) Exposed Spaces	RB	2"	(1)(4)
3.	Return Duct within a plenum ceiling	NONE		(9)
4.	Exhaust Fan Ductwork	NONE		(5)
	a) Between the backdraft or mechanical damper and the space (ductwork having room conditioned ductwork), no insulation is required. All other exhaust ductwork (or if there is no damper present) shall be insulated as outside air ductwork.			
5.	Duct Coils (coil & duct 3'-0" min. upstream & downstream, including the coil)	FB	2"	(2)

Schedule Notes:

(1) Weld pins with tapered joints.
(2) Stapled edge with mechanical fasteners on ducts over 24" wide.
(3) Provide insulation whether duct is lined or not
(4) Ducts with internal liner do not require additional insulation unless otherwise noted. This does not apply to special 14 gauge supply duct.
(5) Exhaust duct exposed to air at ambient temperature must meet the requirements listed above.
(6) Provide continuous, water tight jacketing over all exterior ductwork.
(7) For ductwork over 24" wide, pitch insulation towards sides of duct.
(8) Pitch insulation at equipment connections away from equipment to prevent pooling and intake of water.
(9) Exterior insulation is not required on return ductwork contained within areas with a ceiling acting as a plenum return – provide exterior insulation per schedule on return ductwork when outside of areas of plenum return.

D. Duct insulating materials shall be as follows:

1. FB: Flexible fiberglass blanket type duct wrap with factory applied foil faced jacketing reinforced with fiberglass scrim laminated to UL rated kraft. Minimum thickness = 2in. Insulation shall be 1-lb/ft3 with a thermal conductivity (k-value) of 0.25 Btu x in/(hr x ft^2 x °F) at 75°F mean temperature when compressed. Provide with 2" stapling tab. Provide Type #100, Johns Manville; or equal.

2. RB: Factory fabricated rigid fiberglass board with factory applied white kraft facing bonded to aluminum foil, reinforced with fiberglass yarn. Minimum thickness = 2in. Temperature limit 450°F unfaced side, 3.0 lb./cu. ft. density. Thermal conductivity (k-value) of 0.23 Btu x in/(hr x ft^2 x °F) at 75°F mean temperature. Insulation to have a R value of 4.3 per inch. Type #814, Johns Manville; or equal.

PART 3 - EXECUTION

3.01 INSTALLATION OF DUCTWORK INSULATION

A. All insulation, jacketing and accessories are to be installed in strict accordance with manufacturer's instructions.

B. Flexible Blanket Insulation (FB): Insulation shall be tightly wrapped around ductwork with all circumferential joints butted and longitudinal joints overlapped minimum of 2".

1. Adhere insulation to metal with 4" wide strips of insulation bonding adhesive at 8" on center and, on ductwork over 24" wide, additionally secure insulation to bottom with pins welded to duct 18" on center. On circumferential joints, secure 2" flange of facing using 9/16" flare door staples applied 6" on center and tape with 3" wide foil reinforced kraft tape. On longitudinal joints, secure overlap in the same manner. All pin penetrations or punctures in facing shall be similarly taped. If single blanket or sufficient thickness is not available, install two layers of equal thickness with vapor barrier facing on outer layer only.

C. Rigid Board Insulation (RB): Impale insulation over pins welded to duct on 21" centers, cut to extend 1/8" beyond face of board and cover with vapor seal mastic and self-locking cap. Seal all edges and butt joints with 5" wide strips of self-sealing pressure sensitive tape matching surface and finish of duct insulation.

END OF SECTION

SECTION 230719 - PIPING INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.02 SUBMITTALS

A. Schedule of all materials used.

B. Product data for all materials.

1.03 WORK INCLUDED

A. Insulate all pipes as required by contract documents.

PART 2 - PRODUCTS

2.01 PIPING INSULATION

A. The following is a schedule for pipe insulation:

		Pipe Diameter Up To 1-1/4" Min. Insulation Thickness	1-1/2" & Larger Insulation Thickness	Type	Notes
1.	Steam (Low Pressure)	2"	3"	A	(1)(2)(3)(6)
2.	Condensate	2"	3"	A	(1)(2)(3)(6)
3.	Heating Hot Water	1-1/2"	2"	A	(1)(2)(3)(5)(6)
4.	Condensate Drain	1/2"	1/2"	B	(4)
5.	Refrigerant Suction, Liquid Piping and Hot Gas Bypass	1-1/2"	1-1/2"	B	(4)(5)

Schedule Notes:
(1) Pre-Molded PVC Fitting Covers: Zeston, Inc.; or equal.
(2) Self-seal lap.
(3) Staples-outward clinching.
(4) Foamed plastic pipe insulation adhesive; Armstrong Co.; 520 adhesive; or equal.
(5) Exterior insulation shall be covered with jacketing as specified hereinafter.
(6) Furnish high impact strength PVC piping jacketing, as specified hereinafter, for all exposed piping in all finished spaces.

(NOTE: 1-1/2” Insulation is required per the 2015 IECC, substitutions for lesser values of refrigeration thicknesses will not be accepted).

B. Equipment Insulation:

1. All hot water and chilled water fittings, valves, water specialties, flanges, air separators and pumps shall be insulated per this section, NO EXCEPTIONS!

2. Note: Do not run any insulation through pitch pockets.

3. Note: All insulation requirements of this section shall apply to flexible expansion joints (EXP-1).

2.02 MATERIALS FOR PIPING INSULATION

A. Pipe insulating materials shall be as follows:

1. Type A: Fiberglass pipe insulation jacketed with a reinforced vapor retarder jacket and factory applied longitudinal acrylic adhesive closure system. Insulation shall have a maximum service temperature of 850°F with a thermal conductivity (k-value) of 0.23 Btu x in/(hr x ft^2 x °F) at 75°F mean temperature per ASTM C518 and UL rated for maximum flamespread of 25 and smoke developed of 50. Johns Manville. Micro-Lok; or equal.

2. Type B: Closed Cell Foam Pipe Insulation. Insulation shall have a maximum service temperature of 300°F with a thermal conductivity (k-value) of 0.28 Btu x in/(hr x ft^2 x °F) at 75°F mean temperature per ASTM C518 and UL rated for a maximum flamespread of 25 and smoke developed of 50.
   a) Interior use: Pre-slit foamed plastic pipe insulation with slit positioned at side and vapor sealed with adhesive on all joints. AP Armaflex Tube Insulation; or equal.

   b) Exterior use: Composite product comprised of multi-ply PVC/aluminum laminate jacketing that is factory adhered to a closed cell flexible elastomeric foam insulation, rated for maximum flame spread 25 and smoke developed 50, with slit positioned at side. Rivet manufacturers tape along longitudinal seams. Install per manufacturers instructions. K-flex Clad AL K-Flex USA Inc., or equal.

3. Type C: High Temp. Pipe Insulation. Johns Manville, Thermo-12/Gold calcium silicate; or equal. Insulation shall have a maximum service temperature of 1,200°F with a thermal conductivity (k-value) of 0.37 Btu x in/(hr x ft^2 x °F) at 100°F mean temperature per ASTM C518 and UL rated for a maximum flamespread of 0 and smoke developed of 0.

B. High Impact Strength Jacketing: Furnish PVC jacketing and fitting covers, conforming to ASTM E-84; flame spread 25, smoke developed 50, white high gloss finish, 0.02" minimum thickness.

C. Furnish pre-molded PVC jacketing and fitting covers, lo-smoke type, as manufactured by Proto Corp.; or an approved equal.

PART 3 - EXECUTION

3.01 PIPING INSULATION INSTALLATION

A. Type of Insulation Listed and Methods of Installation:

1. Fiberglass Pipe Insulation (A): Butt joints sealed with 3" wide strips of jacket material with factory applied pressure sensitive adhesive, laps and strips applied over clean dry surfaces and all longitudinal and circumferential seams rubbed hard with blunt steel edge. Cover valves, fittings, flanges, etc. with pre-formed fiberglass fittings and premolded PVC plastic jackets.

2. Closed Cell Foam Pipe Insulation (B): Insulate fittings, valves and flanges with mitered and fitted sections of foamed plastic pipe insulation positioned and fastened by adhesive on all joints.

3. Calcium Silicate Pipe Insulation (C): Secure insulation with stainless steel bands at 12-inch (300-mm) intervals, and tighten bands without deforming insulation materials. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

B. Special Requirements:

1. Heating piping hangers shall be applied directly to piping. Cut-out insulation for hanger and cover with jacketing. Insulation shall be "butt-up" to hanger as tightly as possible.

2. Cooling/refrigeration piping insulation shall be continuous and have no breaks, insulation shield shall be applied between insulation and hanger.

END OF SECTION

SECTION 230993 – TEMPERATURE CONTROLS

PART 1 – GENERAL

1.01 RELATED SECTIONS

A. The General Conditions of the Contract, Supplementary Conditions, and General Requirements are part of this specification and shall be used in conjunction with this section as part of the contract documents. Consult the above for further instructions pertaining to this work. The Contractor is bound by the provisions of Division 0 and Division 1.

1.02 CONNECTION TO EXISTING CONTROL SYSTEM

A. All new control equipment must integrate seamlessly with existing Automated Control Logic (ACL) Schneider Electric DDC system. All new digital controllers are required to communicate fully with the existing temperature control network.

B. All new controllers provided under this project must be connected to the existing BAS System. Extend network (including software) as required to provide a fully integrated control system.

C. BAS System Contractor shall modify programming in host computer to accept all new equipment and I/O points.

D. Contractor must visit site to inspect existing equipment required for operation of new systems. If existing miscellaneous equipment is not of sufficient size or is not functioning properly, contractor must include replacement or refurbishment in his bid.

1.03 ACCEPTABLE MANUFACTURERS

A. Maufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Automated Control Logic

Note: ACL is the districts preferred contractor.

B. If the Contractor is proposing to provide a product by a Manufacturer other than those listed above, the Contractor must, at least 10 days prior to bid opening, to obtain the approval of the Owner for the equal manufacturer, along with provided 5 references of sites where the company has performed projects to similar type.

1.04 CONTROL SYSTEM DESCRIPTION

A. Provide labor, controls materials, controls equipment and services as required for a complete BACnet Building Automation System (BAS), to perform the functions described in this Section. Controls System shall be Web-based and accessible either directly connected and/or through the owners IP LAN network.

B. It is the BAS manufacturer's responsibility to provide all the design, engineering, and field coordination required to ensure all equipment sequence of operations are met as specified and the designated BAS operators have the capability of managing the building mechanical system.

C. The BAS shall meet BACnet communication standards to ensure the system maintains "interoperability" to avoid proprietary arrangements that will make it difficult for the Owner to consider other BAS manufacturers in future projects. These open protocol communication standards are discussed in more detail later in this specification.

D. BAS controllers shall be listed by BACnet Testing Laboratories (BTL) with appropriate classification.

E. Direct Digital Control (DDC) technology shall be used to provide the functions necessary for control of mechanical systems and equipment on this project.

F. The BAS shall accommodate simultaneous multiple user operation. Access to the control system data should be limited only by the security permissions of the operator role. Multiple users shall have access to all valid system data. An operator shall be able to log onto any workstation on the control system and have access to all appropriate data.

G. The BAS manufacturer shall provide all hardware and software necessary to implement the functions and sequence of operations specified.

1.05 SUBMITTAL REQUIREMENTS

A. BAS manufacturer shall provide shop drawings and manufacturers' standard specification data sheets on all hardware and software being provided for this project. No work may begin on any segment of this project until the Engineer has reviewed submittals for conformity with the plan and specifications. Five (5) copies are required. All shop drawings shall be provided to the Owner electronically once they have been approved and as-built drawings have been completed.

B. Quantities of items submitted shall be reviewed by the Engineer. Such review shall not relieve the BAS manufacturer of furnishing quantities required based upon contract documents.

C. Provide the Engineer with any additional information or data which is deemed necessary to determine compliance with the specifications or which is deemed valuable in documenting and understanding the system to be installed.

D. Submit the following within 45 days of contract award:

1. A complete bill of materials of equipment to be used indicating quantities, manufacturers and model numbers.

2. A schedule of all control valves including the valve size, pressure drop, model number (including pattern and connections), flow, CV, body pressure rating, and location.

3. A schedule of all control dampers including damper size, pressure drop, manufacturer, and model number.

4. Note: schedule of valves and dampers shall be submitted independently of other submittals; do not combine with other submittals.

5. Provide all manufacturers' technical cut sheets for major system components. When technical cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Include:
   a) Building Controllers
   b) Custom Application Controllers
   c) Application Specific Controllers

d) Operator Workstations
e) Portable Operator Terminals
f) Auxiliary Control Devices

6. Room schedule including a separate line for each VAV box and/or terminal unit indicating location and address.

7. Samples of graphic display screen types and associated menus.

8. Provide proposed Building Automation System architectural diagram depicting various controller types, workstations, device locations, addresses, and communication cable requirements.

9. Provide detailed termination drawings showing all required field and factory terminations, as well as terminal tie-ins to DDC controls provided by mechanical equipment manufacturers. Terminal numbers shall be clearly labeled.

10. Provide points list showing all system objects and the proposed object names.

11. Provide a sequence of operation for each controlled mechanical system and terminal end devices.

12. Provide a BACnet Protocol Implementation Conformance Statement (PICS) for each BACnet system level device (i.e. Building Controller & Operator Workstations) type. This defines the points list for proper coordination of interoperability with other building systems if applicable for this project.

E. Project Record Documents: Upon completion of installation, submit PDF of record (as-built) documents. The documents shall be submitted for approval prior to final completion and include:

1. Project Record Drawings - These shall be as-built versions of the submittal shop drawings. One set of electronic drawing files shall be provided.

2. Testing and Commissioning Reports and Checklists signed off by trained factory (equipment manufacturers) and field (BAS) commissioning personnel.

3. Operating and Maintenance (O & M) Manuals - These shall be as-built versions of the submittal product data. In addition to the information required for the submittals, Operating & Maintenance manual shall include:
   a) Names, address and 24-hour/7-day per week telephone numbers of Contractor personnel managing and installing equipment, along with service personnel responsible for supporting the ongoing warranty and services of the control system.

   b) Procedures for operating the BAS including logging on/off, alarm management, generation of reports, trends, overrides of computer control, modification of setpoints, and other interactive system requirements.

   c) Description of the programming language including syntax, statement descriptions, algorithms, calculations, point database creation and modification, program creation and modification, and operator use of the editor.

   d) Explanation of how to design and install new points, new DDC controllers, and other BAS hardware.

e) Preventative Maintenance and calibration procedures; hardware troubleshooting; and hardware repair and/or replacement procedures.

f) Documentation of all software program logic created for Custom Programmable Controllers including the overall point database. Provide one set of magnetic media containing files of the software and point database.

g) One set of electronic media containing files of all operator color graphic screens for the project.

h) A list of recommended spare parts including pricing, manufacturer, supplier, and part numbers.

i) Documentation, installation, and maintenance information for all third party hardware/software products provided including personal computers, printers, hubs, sensors, valves, etc.

j) Original issue media for all software provided, including operating systems, programming language, operator workstation software, and graphics software.

k) Licenses, Guarantee, and Warranty documents for all equipment and systems.

1.06 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 232113 – Hydronic Piping

1. Control Valves
2. Temperature Sensor Wells and Sockets
3. Hydronic Pressure Taps
4. Hydronic Flow Meters

B. Section 233300 – Ductwork Accessories

1. Automatic Dampers
2. Airflow Stations

1.07 DEFINITIONS

Term	Definition
UCP	Unitary Controller
ACP	Air Handler Controller
BACnet/BACnet Standard	BACnet communication requirements as defined by the latest version of ASHRAE/ANSI 135 and approved addenda.
Control Systems Server	A computer(s) that maintain(s) the systems configuration and programming database.
Controller	Intelligent stand-alone control device. Controller is a generic reference to building controllers, custom application controllers, and application specific controllers.
Direct Digital Control	Microprocessor-based control including Analog/Digital conversion and program logic.
Gateway	Bi-directional protocol translator connecting control systems that use different communication protocols.
Local Area Network	Computer or control system communications network limited to local building or campus.
Master-Slave/Token Passing (MS/TP)	Data link protocol as defined by the BACnet standard.
Point-to-Point	Serial communication as defined in the BACnet standard.
Primary Controlling LAN	High speed, peer-to-peer controller LAN connecting BCs and optionally AACs and ASCs. Refer to System Architecture below.
Protocol Implementation Conformance Statement (PICS)	A written document that identifies the particular options specified by BACnet that are implemented in a device.
Router	A device that connects two or more networks at the network layer.
Wiring	Raceway, fittings, wire, boxes and related items.

1.08 CODES AND STANDARDS

A. Codes and Standards: Meet requirements of all applicable standards and codes, except when more detailed or stringent requirements are indicated by the Contract Documents, including requirements of this Section.

1. Underwriters Laboratories: Products shall be UL-916-Energy Management Systems for BAS components & ancillary equipment

2. Underwriters Laboratories: Products shall be UL-873 Temperature Indication & Regulating Equipment.

3. Federal Communications Commission –Part 15- Subpart J.

4. All products shall be labeled with the appropriate approval markings. System installation shall comply with NFPA, NEMA, Local and National Standards.

5. ASHRAE/ANSI 135-2012 (BACnet) - (System Level Devices) - Building Controllers shall conform to the listed version of the BACnet specification in order to improve interoperability with various building system manufacturers' control systems and devices.

6. ASHRAE/ANSI 135-2012 (BACnet) - (Unit Level Devices) - Unit Controllers shall conform to the listed version of the BACnet specification in order to improve interoperability with various building system manufacturers' control systems and devices.

1.09 QUALITY ASSURANCE

A. BAS Manufacturer Qualifications

1. The BAS manufacturer shall have an established business office within 100 miles of the project site and must provide 24 hours/day, 7 days/week response in the event of a customer warranty or service call.

2. The BAS Manufacturer shall have factory trained and certified personnel providing all engineering, service, startup, and commissioning field labor for the project from their local office location. BAS manufacturer shall be able to provide training certifications for all local office personnel upon request.

3. The BAS shall be provided by a single manufacturer and this manufacturer's equipment must consist of operator workstation software, Web-based hardware/software, Open Standard Protocol hardware/software, Custom application Programming Language, Graphical Programming Language, Building Controllers, Custom Application Controllers, and Application Specific Controllers. All other products specified herein (i.e., sensors, valves, dampers, actuators, etc.) need not be manufactured by the BAS manufacturer listed in this specification.

1.10 SYSTEM PERFORMANCE

A. Performance Standards. The BAS system shall conform to the following:

1. Graphic Display. The system shall display a graphic with a minimum of 20 dynamic points. All current data shall be displayed within 10 seconds of the operator's request.

2. Graphic Refresh. The system shall update all dynamic points with current data within 10 seconds.

3. Object Command. The maximum time between the command of a binary object by the operator and the reaction by the device shall be 5 seconds. Analog objects shall start to adjust within 5 seconds.

4. Object Scan. All changes of state and change of analog values shall be transmitted over the high-speed network such that any data used or displayed at a controller or workstation will be current within the prior 10 seconds.

5. Alarm Response Time. The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed 10 seconds.

6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 seconds. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.

7. Programmable Controllers shall be able to execute DDC PID control loops at a selectable frequency from at least once every 5 seconds. The controller shall scan and update the process value and output generated by this calculation at this same frequency.

8. Multiple Alarm Annunciations. All workstations on the network shall receive alarms within 5 seconds of each other.

9. Reporting Accuracy. Table 1 lists minimum acceptable reporting accuracies for all values reported by the specified system.
   a) Table 1: Reporting Accuracy *(applicable to the project)*

Measured Variable	**Reported Accuracy**
Space Temperature	±1°F
Ducted Air	±2°F
Outside Air	±2°F
Water Temperature	±1°F
Delta –T	±0.25°F
Relative Humidity	±5% RH
Water Flow	±5% of full scale
Air Flow (terminal)	±10% of reading
Air Flow (measuring stations)	±5% of reading
Air Pressure (ducts)	±0.1 "W.G.
Air Pressure (space)	±0.01 "W.G.
Water Pressure	±2% of full scale *Note 1
Electrical Power	5% of reading *Note 2
Carbon Monoxide (CO)	± 50 PPM
Carbon Dioxide (CO2)	± 50 PPM

Note 1: for both absolute and differential pressure
Note 2: * not including utility supplied meters

1.11 WARRANTY REQUIREMENTS

A. Warranty all work as follows:

1. BAS system labor and materials shall be warranted free from defects for a period of twelve (12) months after final completion acceptance by the Owner. BAS failures during the warranty period shall be adjusted, repaired, or replaced at no charge to the Owner. The BAS manufacturer shall respond to the Owner's request for warranty service within 24 hours of the initiated call and will occur during normal business hours.

2. At the end of the final start-up/testing, if equipment and systems are operating satisfactorily to the Owner and Engineer, the Owner shall sign certificates certifying that the BAS is operational, and has been tested and accepted in accordance with the terms of this specification. The date of Owner's acceptance shall be the start of the warranty period.

3. Operator workstation software, project specific software, graphics, database, and firmware updates shall be provided to the Owner at no charge during the warranty period. Written authorization by the Owner must be granted prior to the installation of these updates.

4. The BAS manufacturer shall provide a web-accessible Users Network for the proposed System and give the Owner free access to question/answer forum, user tips, upgrades, and training schedules for a one year period of time correlating with the warranty period.

1.12 SYSTEM MAINTENANCE

A. Perform Building Automation System preventative maintenance and support for a period of 1 year (beginning the date of substantial completion).

1. Make a minimum of 2 complete Building Automation System inspections, in addition to normal warranty requirements. Inspections to include:
   a) System Review – Review the BAS to correct programming errors, failed points, points in alarm, and points that have been overridden manually.

   b) Seasonal Control Loop Tuning – Control loops are reviewed to reflect changing seasonal conditions and/or facility heating and cooling loads.

   c) Sequence of operation verification – Systems all verified to be operating as designed and in automatic operation. Scheduling and setpoints are reviewed and modified.

   d) Database back-up

   e) Operator coaching

2. Technician shall review critical alarm log and advise owner of additional services that may be required.

3. Technician shall provide a written report to owner after each inspection.

B. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of owner.

1.13 OWNERSHIP OF PROPRIETARY MATERIAL

A. Project specific software and documentation shall become the owner's property upon project completion.

1.14 SEQUENCE OF OPERATION

A. Unit Shut Down

1. All units connected to FACP shall be shut down in the event of fire. (By EC via fire alarm system).

2. All units with low limit controllers (freezestats) shall be shut down if supply air temperature drops below 35°F. Shut down includes closing OA dampers, shut down fan, open control valve (or face damper).

3. All low limit controls shall be hard wired to break fan controls. Wiring low limit through DDC is not permitted to break fan controls. Wiring from LC-1 to DDC system is for alarm purposes only.

4. When low limit control is activated, send auxiliary alarm signal to DDC unit controller. DDC system shall annunciate alarm condition.

5. **All temperature control valves and dampers will be spring return and shall fail to the "Safe" position for that system.**

6. **Bypass valve application will be size for 50% of the pump capacity of that system.**

B. Remote Monitoring:

1. Provide all software necessary to monitor all sensors, equipment status and alarm conditions at operate workstation and local second tier controllers.

2. Provide all software necessary to recognize, process and record alarm conditions as required by Owner.

C. Occupied/Unoccupied Cycle:

1. Each system with DDC controls shall function as an individual D/N zone with individual event times for start/stop.

2. Stagger initial start times to prevent simultaneous occupied cycle activation for all equipment.

3. In unoccupied cycle, when room sensor override button is pushed, start software timer (setpoint 2 hours) to provide Day (occupied) cycle for a software selectable period of time after which system reverts to Night (unoccupied) cycle.

4. While software timer is operating ignore additional override switch signals. System shall ignore switch signals initiated when area is in occupied cycle.

D. Morning Warm-Up: Provide software routine to initiate morning warm-up when outdoor conditions dictate, warm-up schedule shall be adaptive (i.e. optimize energy usage). During morning warm-up for classrooms and shop areas with motion detector, the detector is overridden until room occupied temperature setpoint is reached, duration (2) hours (adjustable).

E. Refer to drawings for unit specific sequences.

PART 2 – PRODUCTS

2.01 GENERAL DESCRIPTION

A. The Building Automation System (BAS) shall use us an open BACnet architecture and DDC controllers that are certified by BACnet Testing Laboratories (BTL) with the appropriate classifications. The BAS shall be capable to integrae to third-party devices and applications. The system shall be for use on the the Internet, or intranets using off the shelf, industry standard technology compatible with the owner provided network.

B. The Building Automation System (BAS) shall consist of the following:

1. BACnet Testing Laboratories Certified Controllers
2. Portable Operator Terminal(s)
3. Networking processing, data storage, and communications equipment
4. Other controls components required for a complete and working BAS

C. The Building Automation System (BAS) shall be modular in nature, and shall permit expansion of both capacity and functionality through addition of sensors, controllers, actuators, and operator devices, whilre reusing existing controls equipment.

2.02 BAS ARCHITECTURE

A. Communication Network

1. This project shall be comprised of a high speed Ethernet network utilizing BACnet/IP communications between System Controllers and Workstations. Each System Controller shall function as a BACnet Router to each unit controller providing a unique BACnet Device ID for all controllers within the system. Communications between System Controllers and sub-networks of Custom Application Controllers and/or Application Specific Controllers shall be as defined below.

2. Each System Controller shall perform communications to a network of Custom Application and Application Specific Controllers using BACnet/Zigbee (802.15.4) as defined by the Zigbee Standard.
   a) Each communication interface shall be Zigbee Building Automation Certified product as defined by the BACnet Standard and the Zigbee Alliance.
   b) Each System Controller shall function as a BACnet Router to each unit controller providing a unique BACnet Device ID for all controllers within the system.
   c) Wireless equipment controllers and auxiliary control devices shall conform to:
      (1) IEEE 802.15.4 radios to minimize risk of interference and maximize battery life, reliability, and range.
      (2) Communication between equipment controllers shall conform to ZigBee Building Automation (ZBA) standard as BACnet tunneling devices to ensure future integration of other ZBA certified devices.
      (3) Operating range shall be a minimum of 200 feet (60 m); open range shall be 2,500 ft. (762 m) with less than 2% packet error rate.
      (4) To maintain robust communication, mesh networking and two-way communications shall be used to optimize the wireless network health.
      (5) Wireless communication shall be capable of many-to-one sensors per controller to support averaging, monitoring, and multiple zone applications.
      (6) Certifications shall include FCC CFR47 - RADIO FREQUENCY DEVICES - Section 15.247 & Subpart E.

3. Each System Controller shall perform communications to a network of Custom Application and Application Specific Controllers using BACnet/MSTP (RS485) as defined by the BACnet standard.

B. Integrator Panel:

1. The BAS System shall include appropriate hardware equipment and software to allow bi-directional data communications between the BAS and the 3rd Party manufacturers' control panels. The BAS shall receive, react to, and return information from multiple building systems, including equipment manufacturers' integral packaged controls that do not have the BACnet protocol.

2. All data required by the application shall be mapped into the BAS database, and shall be transparent to the operator.

3. Point inputs and outputs from from the third-party controllers shall have real-time interoperability with the BAS such as: Control Software, Energy Management, Custom Process Programming, Alarm Management, Historical Data and Trend Analysis, and Local Area Network Communications.

BACNET Protocol Integration:

4. The neutral protocol used between systems will be BACnet and must comply with the ASHRAE BACent standard 135.

5. A complete Protocol Implementation Conformance Statement (PICS) shall be provided for all BACnet system devices.

6. The ability to command, share point object data, chance of state data, and schedules between the host and BACnet systems shall be provided.

C. The Controls Contractor shall provide all communication media, connectors, repeaters and network switches routers necessary for the high speed Ethernet communications network.

2.03 OPERATOR USER INTERFACE

A. Furnish 1 PC based operator interface as shown on the system drawings. Each operator web interface shall be able to access all information in the system. Operator interfaces shall reside on the same dedicated high-speed IP network as the System Controller(s).

1. Each operator interface PC shall include the following:
   a) Hardware type
      (1) PC or Laptop
   b. Minimum Hardware
      (1) Pentium Core 2 DUO or better
      (2) 4 GB RAM
      (3) 100 GB hard drive space
   c. Internet Browser compatibility outlined in the following sections.

B. Operator web interface

1. The operator web interface shall be accessible via a web browser without requiring any “plug-ins” (i.e. JAVA Runtime Environment (JRE), Adobe Flash).

2. The operator web interface shall support the following Internet web browsers:
   a) Internet Explorer 11.0+
   b) Firefox 47.0+
   c) Chrome 51.0+

3. System Security
   a) Each operator shall be required to login to the system with a user name and password in order to view, edit, add, or delete data.

   b) User Profiles shall restrict the user to only the objects, applications, and system functions as assigned by the system administrator.

   c) Each operator shall be allowed to change their user password.

   d) The System Administrator shall be able to manage the security for all other users.

   e) The system shall include pre-defined “roles” that allow a system administrator to quickly assign permissions to a user.

   f) User logon/logoff attempts shall be recorded.

g) The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user definable.

h) All system security data shall be stored in an encrypted format.

i) The system shall support Active Directory for user set-up and management.

j) The system shall track and record all user log-in activity and all changes done at the enterprise level including who made the change, when, what was changed, pervious value and new value.

4. Database
   a) Database Save: A system operator with the proper password clearance shall be able to archive controller back-ups on the designated Enterprise operator web interface PC.

   b) Database Restore: The system operator shall also be able to clear a panel database and manually initiate a download of a specified database to any panel in the system.

   c) Database Limits. The system operator shall have the ability to set limits on Alarm Log, Global Point Control Log, System Log, and User Change Log to manage database size.

5. On-line Help and Training
   a) Provide a context sensitive, on line help system to assist the operator in operation and configuration of the system.

   b) On-line help shall be available for all system functions and shall provide the relevant data for each particular screen.

6. System Diagnostics
   a) The system shall automatically monitor the operation of all network connections, building management panels, and controllers

   b) The failure of any device shall be annunciated to the operators.

7. Customizable Navigation Tree
   a) The Enterprise operator web interface shall include a fully customizable navigation tree that shall allow an operator to do the following:
      (1) Move and edit any of the nodes of the tree.
      (2) Move entire groups to any area of the tree
      (3) Change the name of any node in the tree
      (4) Create custom nodes for any page in the web interface including graphics, data log views, schedules, and dashboards.
      (5) Support navigation from multi-building to single building view.
      (6) Provide the ability to assign graphics to any node in the tree.
      (7) Ability to create folders and assign and change hierarchy of nodes of the tree.

8. Equipment & Application Pages
   a) The Enterprise operator web interface shall include standard pages for all equipment and applications. These pages shall allow an operator to obtain information relevant to the operation of the equipment and/or application, including:
      (1) Animated Equipment Graphics for each major piece of equipment and floor plan in the System.

(2) Alarms relevant to the equipment or application without requiring a user to navigate to an alarm page and perform a filter.
(3) Historical Data (As defined in Data Log section below) for the equipment or application without requiring a user to navigate to a Data Log page and perform a filter.
(4) View of all custom graphical programming for supported controllers in real time.
(5) View and management of all points for equipment and applications.
(6) Support documents that have been assigned for that equipment.
(7) Live data view for any selected points.
(8) Touch friendly design for all action buttons, navigation, and spacing.

9. System Graphics. Enterprise operator web interface shall be graphically based and shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using colors to represent zone temperature relative to zone set point.
   a) Functionality. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point and-click navigation between zones or equipment, and to edit set points and other specified parameters.

   b) Graphic imagery – graphics shall use 3D images for all standard and custom graphics. The only allowable exceptions will be photo images, maps, schematic drawings, and selected floor plans.

   c) Animation. Graphics shall be able to animate by displaying different Image lies for changed object status.

   d) Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.

   e) Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins (such as Active-X and Macromedia Flash).

10. Custom Graphics
   a) The operator interface shall be capable of displaying custom graphics in order to convey the status of the facility to its operators.

   b) Graphical Navigation. The Enterprise operator web interface shall provide dynamic color graphics of building areas, systems and equipment.

   c) Graphical Data Visualization. The Enterprise operator web interface shall support dynamic points including analog and binary values, dynamic text, static text, and animation files.

   d) Custom background images. Custom background images shall be created with the use of commonly available graphics packages such as Adobe Photoshop. The graphics generation package shall create and modify graphics that are saved in industry standard formats such as GIF and JPEG.

11. Graphics Library. Furnish a library of standard HVAC equipment such as chillers, air handlers, terminals, fan coils, unit ventilators, rooftop units, and VAV boxes, in 3-dimensional graphic depictions. The library shall be furnished in a file format compatible with the graphics generation package program.

12. Document Support. The Enterprise operator web interface shall support the ability to import support files into a support files library.
    a) Imported support files can include the following types of document formats: pdf, docx, xlsx, pptx, jpeg, tif, bmp, png, jpg, gif.

    b) All imported support files can be associated directly with equipment or family types that can then be accessed directly from standard pages.

13. Manual Control and Override
    a) Point Control. Provide a method for a user to view, override, and edit if applicable, the status of any object and property in the system. The point status shall be available by menu, on graphics or through custom programs.

    b) Temporary Overrides. The user shall be able to perform a temporary override wherever an override is allowed, automatically removing the override after a specified period of time.

    c) Override Owners. The system shall convey to the user the owner of each override for all priorities that an override exists.

    d) Provide a specific icon to show timed override or operator override, when a point, unit controller or application has been overridden manually.

    e) Global Point Control. Provide a method for a user to view, override, and edit if applicable, the status of multiple object and properties in the system. The point status shall be available by menu, on graphics or through custom programs.

14. Engineering Units
    a) Allow for selection of the desired engineering units (i.e. Inch pound or SI) in the system.

    b) Unit selection shall be able to be customized by locality to select the desired units for each measurement.

15. Scheduling. A user shall be able to perform the following tasks utilizing the Enterprise operator web interface:
    a) Create a new schedule, defining the default values, events and membership.

    b) Create expectations to a schedule for any given day.

    c) Apply an exception that spans a single day or multiple days.

    d) View a schedule by day, week and month.

    e) Exception schedules and holidays shall be shown clearly on the calendar.

    f) Modify the schedule events, members and exceptions.

    g) Create schedules and exceptions for multiple buildings.

    h) Apply emergency schedule to multiple buildings

i) Drag and drop scheduling editing

j) Global schedule and exceptions across multiple buildings

16. Time of day scheduling
    a) Individual time schedules shall be provided for all areas and as listed below. The schedules for each area shall operate independently and shall be configured to meet the requirements of the Owner. The start time of each area shall be configured with optimum start times software functions, stop times shall follow a simple off time schedule.

Areas	**Approx. Occupied Time**
Office Areas	06:30 - 17:00
Classroom	07:00 - 15:00
Library	07:00 - 15:00
Toilet Room Exhaust Fans	06:00 - 20:00
Gymnasium	09:00 - 15:00
Auditorium	09:00 - 15:00
Kitchen	06:00 - 1500
Open Area	07:00 - 17:00

Note: General equipment associated with a particular area shall follow the area start/stop time schedule (i.e. – classroom general exhaust fans shall stop @ 15:00).

17. Data Logs
    a) Data Logs Definition
        (1) The Enterprise operator web interface shall allow a user with the appropriate security permissions to define a Data Log for any data in the system.
        (2) The Enterprise operator web interface shall allow a user to define any Data Log options as described in the Application and Control Software section.
        (3) Data Log viewing capabilities shall include the ability to show a minimum of 5 points on a chart.
        (4) Each data point data line shall be displayed as a unique color.
        (5) Data points can be hidden on the display view by clicking on the point.
        (6) The operator shall be able to specify the duration of historical data to view by scrolling, zooming, or selecting from a pull down list.
        (7) The system shall provide a graphical trace display of the associated time stamp and value for any selected point along the x-axis.
        (8) Operator will have the ability to show alarms and overrides on any data log view.

    b) Export Data Logs
        (1) The Enterprise operator web interface shall allow a user to export Data Log data in CSV, xlsx or text format for use by other industry standard word processing and spreadsheet packages.

C. Central Server – Components (Provide server as required)

1. The central physical or virtual server shall consist of the following (minimum):
2. System shall utilize a server class PC, tower or rack mounted.
3. Two 3.0 GHz, Quad Core
4. 8GB, DDR266 SDRAM memory
5. Hard Drive 73 GB
6. RAID 5 (recommended)
7. Microsoft Windows Server 2012/2014

8. Microsoft SQL Server 2008/2012
9. No Exception Taken Framework V3.5, 4.0
10. TCP/IP Interface

D. The central server shall provide the following applications within the system.

1. Trend Log Application
   a) The system shall automatically harvest trend logs for defined key measurements for each controlled HVAC device and HVAC application.
   b) The automatic trend logs shall monitor these parameters for a minimum of 30 days at 15 minute intervals. The automatic trend logs shall be user adjustable.

2. Site Management
   a) The system must allow for grouping of the many sites in an enterprise in a logical manner.
   b) The system shall provide a search function to allow users to search for sites or groups of sites by name or partial names.
   c) The system must provide the necessary means to add, remove, and manage site.

3. Automatic System Database Save and Restore
   a) The central server shall store on the hard disk backup tables of data including trends, alarms, custom settings and user profiles.
   b) The data shall be backed up once a day.
   c) This database shall be updated whenever a change is made in the system.
   d) The storage of this data shall be automatic and not require operator intervention.
   e) This capability is completed through SQL scheduled automated tasks for backup and only available in full SQL, and not SQL Express.

4. Manual Database Save and Restore. A system operator with the proper password clearance shall be able to archive the database manually at any time.

5. System Configuration. The central server shall serve web pages as the interface for configuring the operator-level functions of the system. A user with proper security shall be able to configure the system to allow for future changes or additions.

E. Portable Operator's Terminal P.O.T (where indicated).: (Intended for portable field diagnostic tool.) Provide laptop computer with terminal emulation software to interface with DDC panels. Computer shall be Windows platform with latest stable windows operating system (Windows 8.1) integral pointing device. Furnish unit with all interface cards, cables, and software necessary to operate with DDC communications network, and to communicate directly with unit control panels. Furnish with (2) sets interface cables. Provide Windows 8.1 software. Schedule of laptop computer requirements:

Processing Chip	Pentium N3540, 2.5 GHz
RAM Memory	4 GB
Hard Drive	500 GB 5400 RPM
Two USB	USB 2.0 Ports and 3.0 Ports
Display	15” LED True Life HD
Video	HDMI Port
Sound	Maxx Audio
LAN Comm.	Ethernet Communications Board, 3COMM; or equal
Wireless Card	3-1 Memory Card Reader

F. Furnish the following applications software for building and energy management. All software applications shall reside and run in the system controllers. Editing of applications shall occur at the building operator interface.

1. Scheduling. Provide the capability to schedule each object or group of objects in the system based off of the owner's request. Each of these schedules shall include the capability for start, stop, optimal start, optimal stop, and night economizer actions. Each schedule may consist of up to [10] events. When a group of objects are scheduled together, provide the capability to define advances and delays for each member. Each schedule shall consist of the following:
   a) Weekly Schedule. Provide separate schedules for each day of the week.

   b) Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. This exception schedule shall override the standard schedule for that day. 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.

   c) 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.

   d) Optimal Start. The scheduling application outlined above shall support an optimal start algorithm. This shall calculate the thermal characteristics of a zone and start the equipment prior to occupancy to achieve the desired space temperature at the specified occupancy time. The algorithm shall calculate separate sets of heating and cooling rates for zones that have been unoccupied for less then and greater than 24 hours. Provide the ability to modify the start algorithm based on outdoor air temperature. Provide an early start limit in minutes to prevent the system from starting before an operator determined time limit.

2. Trend Log Application
   a) Trend log data shall be sampled and stored on the System Controller panel and shall capable of being archived to a BACnet Workstation for longer term storage.
   b) Trend logs shall include interval, start-time, and stop-time.
   c) Trend log intervals shall be configurable as frequently as 1 minute and as infrequently as 1 year.

3. Trend Logs
   a) The system controller shall create trend logs for defined key performance indicators for each controlled HVAC device and HVAC application.
   b) The trend logs shall monitor these parameters for a minimum of 7 days at 15 minute intervals. The automatic trend logs shall be user adjustable.

4. Alarm/Event Log
   a) Any object in the system shall be configurable to generate an alarm when transitioning in and out of a normal or fault state.
   b) Any object in the system shall allow the alarm limits, warning limits, states, and reactions to be configured for each object in the system.
   c) An alarm/event shall be capable of triggering any of the following actions:
      (1) Route the alarm/event to one or more alarm log
      (2) The alarm message shall include the name of the alarm location, the device that generated the alarm, and the alarm message itself.
      (3) Route an e-mail message to an operator(s).

(4) Log a data point(s) for a period of time.
(5) Run a custom control program.

5. Point Control. User shall have the option to set the update interval, minimum on/off time, event notification, custom programming on change of events.

6. Timed Override. A standard application shall be utilized to enable/disable temperature control when a user selects on/cancel at the zone sensor, building operator interface, or the local operator display. The amount of time that the override takes precedence will be selectable from the building operator interface.

7. Anti-Short Cycling. All binary output points shall be protected from short cycling.

8. Alarm/Event Notification:
   a) An operator shall be notified of new alarms/events as they occur while navigating through any part of the system via an alarm icon.

   b) The operator will have the option of selecting an audible alarm notification for all alarm classes they subscribe to.

   c) The system operator will have the option of setting specific times and days that that they will receive alarm notifications.

   d) Provide software alarm points as listed below and as required by the Owner. Contractor shall meet with the Owner to include additional alarm point annunciation as requested by the Owner.

Point	**Alarm Function**
Hardware	Communication Failure Hardware Failure
Space Temperature	Out of Limits (± 5° from setpoint)
Duct Air Temperature	Out of Limits (± 10° from setpoint)
Water Flow Switch	Loss of Flow
Air Flow Switch	Loss of Flow
Water Temperature	Out of Limits (± 10° from setpoint)
Freeze Stat	Report Freeze Condition
Current Flow Switch	Loss of Current (Fan/Pump)

9. User Change Log. The operator shall be able to view all logged user changes in the system from any Enterprise operator web interface.
   a) An operator shall be able to group user changes by: date, affected, date & affected, user, date & user, transaction type, date & transaction type, or sort only.
   b) The operator will have the option of additional filtering capability of: date, transaction, type, user, affected, and details that can be used individually or in conjunction with other filters.

2.04 BUILDING CONTROLLERS

A. There shall be one or more independent, standalone microprocessor based System Controllers to manage the global strategies described in Application and Control Software section.

1. The System Controller shall have sufficient memory to support its operating system, database, and programming requirements.

2. The controller shall provide a USB communications port for connection to a PC.

3. The operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.

4. All System Controllers shall have a real time clock.

5. Data shall be shared between networked System Controllers.

6. The System Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall.
   a) Assume a predetermined failure mode.

   b) Generate an alarm notification.

   c) Create a retrievable file of the state of all applicable memory locations at the time of the failure.

   d) Automatically reset the System Controller to return to a normal operating mode.

7. Environment. Controller hardware shall be suitable for the anticipated ambient conditions. Controller used in conditioned ambient shall be mounted in an enclosure, and shall be rated for operation at -40° C to 50° C [-40° F to 122° F].

8. Clock Synchronization:
   a) All System Controllers shall be able to synchronize with a NTP server for automatic time synchronization.

   b) All System Controllers shall be able to accept a BACnet time synchronization command for automatic time synchronization.

   c) All System Controllers shall automatically adjust for daylight savings time if applicable.

9. Serviceability
   a) Provide diagnostic LEDs for power, communications, and processor.

   b) The System Controller shall have a display on the main board that indicates the current operating mode of the controller.

   c) All wiring connections shall be made to field removable, modular terminal connectors.

   d) The System controller shall utilize standard DIN mounting methods for installation and replacement.

10. Memory. The System Controller shall maintain all BIOS and programming information indefinitely without power to the System controller.

11. Immunity to power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shut-down below 80% nominal voltage.

12. BACnet Test Labs (BTL) Listing. Each System Controller shall be listed as a Building Controller (B-BC) by the BACnet Test Labs with a minimum BACnet Protocol Revision of 14.

2.05 ADVANCED APPLICATION CONTROLLERS

A. Advance Application Controllers shall be used to control all equipment or applications of medium and high complexity, including but not limited to Air Handlers, Boiler Plants and Chiller Plants.

B. For Stand-Alone Operation of Advanced Application Controllers:

1. Shall operate a schedule in a standalone application using a Real Time Clock with a 7 day power backup.
   a) The Controller shall have a built in schedule (assessable with or without a display).

   b) Support will be for at least 3 schedules with up to 10 events for each day of the week.

   c) Each of the 3 schedules can be Analog, Binary or Multi-State.

   d) The controller shall support a minimum of 25 exceptions each with up to 10 events.

C. For ease of troubleshooting, the Controller shall support data trend logging.

1. 25,000 samples minimum

2. Trends shall be capable of being collected at a minimum sample rate of once every second.

3. Trends shall be capable of being scheduled or triggered.

D. To meet the sequence of operation for each application, the Controller shall use library programs provided by the controller manufacturer that are either factory loaded or downloaded with service tool to the Controller.

E. Environment. Controller hardware shall be suitable for the anticipated ambient conditions.

1. Storage conditions:
   a) Temperature: -67°F to 203°F (-55°C to 95°C).
   b) Humidity: Between 5% to 100% RH (non-condensing).

2. Operating conditions:
   a) Temperature: -40°F to 158°F (-40°C to 70°C)
   b) Humidity: Between 5% to 100% RH (non-condensing).

3. Controllers used indoors shall be mounted in a NEMA 1 enclosure at a minimum.

4. Controllers used outdoors and/or in wet ambient shall be mounted within NEMA 4 type waterproof enclosures, and shall be rated for operation at -40° F to 158° F [-40° C to 70° C].

F. Input/Output: The Controller shall have on board or through expansion module all I/O capable of performing all functionality needed for the application. Controls provided by the equipment manufacture must supply the required I/O for the equipment. In addition other controls must meet the following requirements.

1. Shall support flexibility in valve type, the controllers shall be capable of supporting the following valve control types: 0-10VDC, 0-5VDC, 4-20mA, 24VAC - 2 position.

2. Shall support flexibility in sensor type, the Controller shall be capable of reading sensor input ranges of 0 to10V, 0 to 20mA, 50ms or longer pulses, 200 to 20Kohm and RTD input.

3. Shall support flexibility in sensor type, all Analog Outputs shall have the additional capability of being programmed to operate as Universal Inputs or Pulse Width Modulation Outputs.

4. Shall support flexibility in sensor type, the Controller and/or expansion modules shall support dry and wetted (24VAC) binary inputs.

5. The controller shall support pulse accumulator for connecting devices like energy meters.

6. In order to support a wide range of devices, the Controller's binary output shall be able to drive at least 10VA each.

7. Any unused I/O that is not needed for the functionality of the equipment shall be available to be used by custom programs on the Controller and by any other controller on the network.

8. The Controller shall provide 24VAC and 24VDC power terminals sensors and other devices required.

9. The Controller shall provide a dedicated static pressure input.

G. Input/Output Expandability – The Controller shall provide the following functionality in order to meet current and future application needs:

1. For the application flexibility, the Controller shall be capable of expanding to a total of at least 100 hardware I/O terminations.

2. Expansion I/O can be mounted up to 650 ft. (200m) from control.

3. Expansion I/O can be added in as small as 4 point increments.

4. To keep BACnet network traffic to a minimum, expansion I/O must communicate via an internal controller communication bus.

H. Serviceability – The Controller shall provide the following in order to improve serviceability of the Controller.

1. Diagnostic LEDs for power/normal operation/status, BACnet communications, sensor bus communications, and binary outputs. All wiring connections shall be clearly labeled and made to be field removable.

2. Binary and analog inputs and outputs shall use removable connectors or be connected to terminal strip external to the control box.

3. Software service tool connection through all of the following methods: direct cable connection to the Controller, connection through another controller on BACnet link and through the Controller's zone sensor.

4. For safety purposes, the controller shall be capable of being powered by a portable computer's USB port for the purposes of configuration, programming and testing programs so that this work can be accomplished with the power off to the associated equipment.

5. The Controller software tool service port shall utilize standard off-the-shelf USB printer cable.

6. Capabilities to temporarily override the BACnet point values with built-in time expiration in the Controller.

7. To aid in service replacement, the Controller shall easily attached to standard DIN rail mounting.

8. For future expansion, the Controller shall be capable of adding sequence of operation programming utilizing service tools software with a graphical programming interface (editing or programming in line code is not permissible).

9. To aid in service replacement, the Controller shall allow for setting its BACnet address via controller mounted rotary switches that correspond to the numerical value of the address. (DIP switch methodologies are not allowed). Setting of the address shall be accomplished without the need of a service tool or power applied to the controller.

10. Controller data shall be maintained through a power failure.

I. Software Retention: All Controller operating parameters, setpoints, BIOS, and sequence of operation code must be stored in non-volatile memory in order to maintain such information for months without power.

J. Transformer for the Controller must be rated at minimum of 115% of ASC power consumption, and shall be fused or current limiting type. 24 VAC, +/- 15% nominal, 50-60 Hz, 24 VA plus binary output loads for a maximum of 12 VA for each binary output.

K. Controller must meet the following Agency Compliance:

1. UL916 PAZX, Open Energy Management Equipment
2. UL94-5V, Flammability
3. FCC Part 15, Subpart B, Class B Limit
4. BACnet Testing Laboratory (BTL) Listed.

L. A Local Operator Touch Sensitive Display shall be provided for Central Plant and Air Handler Controllers at building locations where specified in the sequence of operations or point list.

2.06 APPLICATION-SPECIFIC CONTROLLERS

A. Application Specific Controllers (ASC) shall be microprocessor-based DDC controllers which, through hardware or firmware design, control specified equipment. They are not user programmable, but are customized for operation within the confines of the equipment they are designed to serve.

1. Application Specific Controller are only allowed when both the following are met.
   a) The equipment is compressor based or boiler based.

   b) The controller is provided by the equipment manufacturer and warrantied as part of the equipment.

B. Zone Controllers are controllers that operate equipment that control the space temperature of single zone. Examples are controllers for VAV, Fan coil, Blower Coils, Unit Ventilators, Heat Pumps, and Water Source Heat Pumps.

1. Software
   a) To meet the sequence of operation for each zone control, the controller shall use programs developed and tested by the controller manufacturer that are either factory loaded or downloaded with service tool to the controller.

   b) Stand-Alone Operation: Each piece of equipment specified in section "A" shall be controlled by a single controller and provide stand-alone control in the event of communication failure. In case of communications failure stand-alone operation shall use default values or last values for remote sensors read over the network such as outdoor air temperature.

   c) For controlling ancillary devices and for flexibility to change the sequence of operation in the future, the controller shall be capable running custom programs written in a graphical programming language.

2. Environment: Controller hardware shall be suitable for the anticipated ambient conditions.
   a) Storage: -55° to 203° F and 5 to 95% Rh, non-condensing.
   b) Operating: -40° to 158° F and 5 to 95% Rh, non-condensing.
   c) Controllers used indoors shall be mounted in a NEMA 1 enclosure at a minimum.
   d) Controllers used outdoors and/or in wet ambient shall be mounted within NEMA 4 type waterproof enclosures, and shall be rated for operation at -40° to 158° F.

3. Input/Output:
   a) For flexibility in selection and replacement of valves, the controllers shall be capable of supporting all of the following valve control types 0-10VDC, 0-5VDC, 4-20mA, 24VAC floating point, 24VAC - 2 position (Normally Open or Normally Closed).

   b) For flexibility in selection and replacement of sensors, the controllers shall be capable of reading sensor input ranges of 0 to10V, 0 to 20mA, pulse counts, and 200 to 20Kohm.

   c) For flexibility in selection and replacement of binary devices, the controller shall support dry and wetted (24VAC) binary inputs.

   d) For flexibility in selection and replacement devices, the controller's shall have binary output which are able to drive at least 12VA each.

   e) For flexibility in selection and replacement of motors, the controller shall be capable of outputting 24VAC (binary output), DC voltage (0 to 10VDC minimum range) and PWM (in the 80 to 100 Hz range).

   f) For future needs, any I/O that is unused by functionality of equipment control shall be available to be used by custom program on the controller and by another controller on the network.

   g) For future expansion and flexibility, the controller shall have either on board or through expansion, 20 hardware input/output points. Expansion points must communicate with the controller via an internal communications bus. Expansion points must be capable of being mounted up to 650ft. (200 m)

from the controller. Expansion points that require the BACnet network for communication with the controller are not allowed.

4. Serviceability – The controller shall provide the following in order to improve serviceability of the controller.
   a) Diagnostic LEDs shall indicate correct operation or failures/faults for all of the following: power, sensors, BACnet communications, and I/O communications bus.

   b) All binary output shall have LED's indicating the output state.

   c) All wiring connectors shall removable without the use of a tool.

   d) Software service tool connection through all of the following methods: direct cable connection to the controller, connection through another controller on BACnet link and through the controller's zone sensor.

   e) For safety purposes, the controller shall be capable of being powered by a portable computer for the purposes of configuration, programming, and testing programs so that this work can be accomplished with the power off to the equipment.

   f) Capabilities to temporarily override of BACnet point values with built-in time expiration in the controller.

   g) BACnet MAC Address shall be set using decimal (0-9) based rotary switches.

   h) Configuration change shall not be made in a programming environment, but rather by a configuration page utilizing dropdown list, check boxes, and numeric boxes.

   i) BACnet trending objects resident on controller.
      (1) Minimum of 20,000 trending points total on controller
      (2) Shall be capable of trending all BACnet points used by controller
      (3) Shall be capable of 1 second sample rates on all points

5. Software Retention: All Zone Controller operating parameters, setpoints, BIOS, and sequence of operation code must be stored in non-volatile memory in order to maintain such information for months without power.

6. Transformer for the controller must be rated at minimum of 115% of ASC power consumption, and shall be fused or current limiting type. 24 VAC, +/- 15% nominal, 50-60 Hz, 24 VA plus binary output loads, for a maximum of 12 VA for each binary output.

7. Agency Approval: The controller shall have meet the Agency Compliance:
   a) UL916 PAZX, Open Energy Management Equipment
   b) UL94-5V, Flammability
   c) FCC Part 15, Subpart B, Class B Limit

2.07 INPUT / OUTPUT INTERFACE

A. Hardwired inputs and outputs may tie into the system through building, custom application, or ASCs.

B. All input points and output points shall be protected such that shorting of the point to itself, to another point, or to ground will cause no damage to the controller. All input and output points shall be protected from voltage up to 24V of any duration, such that contact with this voltage will cause no damage to the controller.

C. Binary inputs shall allow the monitoring of on/off signals from remote devices. The binary inputs shall provide a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against the effects of contact bounce and noise. Binary inputs shall sense “dry contact” closure without external power (other than that provided by the controller) being applied.

D. Pulse accumulation input objects. This type of object shall conform to all the requirements of binary input objects and also accept up to 10 pulses per second for pulse accumulation.

E. Analog inputs shall allow the monitoring of low voltage (0 to 10 VDC), current (4 to 20 mA), or resistance signals (thermistor, RTD). Analog inputs shall be compatible with and field configurable to commonly available sensing devices.

F. Binary outputs shall provide for on/off operation or a pulsed low-voltage signal for pulse width modulation control. Binary outputs on building and custom application controllers shall have status lights. Outputs shall be selectable for either normally open or normally closed operation.

G. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0 to 10VDC or a 4 to 20 mA signal as required to provide proper control of the output device. Analog outputs shall not exhibit a drift of greater than 0.4% of range per year.

H. Tri-State Outputs. Provide tri-state outputs (two coordinated binary outputs) for control of three-point floating type electronic actuators without feedback. Use of three-point floating devices shall be limited to zone control and terminal unit control applications (VAV terminal units, duct-mounted heating coils, zone dampers, radiation, etc.). Control algorithms shall run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.

I. System Object Capacity. The system size shall be expandable to at least twice the number of input/ output objects required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The operator interfaces installed for this project shall not require any hardware additions or software revisions in order to expand the system.

2.08 POWER SUPPLIES

A. Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish overcurrent protection in both primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.

1. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in overvoltage and overcurrent protection and shall be able to withstand a 150% current overload for at least three seconds without trip-out or failure.
   a. Line voltage units shall be UL recognized and CSA approved.

2.09 AUXILIARY CONTROL DEVICES

A. Motorized dampers, unless otherwise specified elsewhere, shall be as follows:

1. (**D-1**): Opposed blade damper.

2. (**D-2**): Parallel blade damper.

3. Damper frames shall be 16 gauge galvanized sheet metal or 1/8" extruded aluminum with reinforced corner bracing.

4. Damper blades shall not exceed 8" in width or 48" in length. Blades are to be suitable for medium velocity performance (2,000 fpm). Blades shall be not less than 16 gauge.

5. Damper shaft bearings shall be as recommended by manufacturer for application.

6. All blade edges and top and bottom of the frame shall be provided with compressible seals. Side seals shall be compressible stainless steel. The blade seals shall provide for a maximum leakage rate of 10 CFM per square foot at 2.5" w.c. differential pressure.

7. All leakage testing and pressure ratings will be based on AMCA Publication 500.

8. Individual damper sections shall not be larger than 48" x 60". Provide a minimum of one damper actuator per section.

9. Control dampers shall be parallel or opposed blade types as scheduled on drawings.

10. Acceptable Manufacturer shall be Ruskin, Greenheck, or equal.

B. Electric damper/valve actuators (**ME-1, ME-2, ME-3)**

1. ME-1: Modulating range.

2. ME-2: Two Position.

3. ME-3: Modulating range, for unit ventilators.

4. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator.

5. Where shown, for power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing.

6. Proportional actuators shall accept a 0-10 VDC or 0-20 ma control signal and provide a 2-10 VDC or 4-20 ma operating range.

7. Actuators shall be Underwriters Laboratories Standard 873 listed.

8. Acceptable Manufacturer shall be Belimo or equal.

C. Control Valves

1. Control valves shall be two-way or three-way type for two-position or modulating service as scheduled or shown.

2. Size control valves according to chart below: (Maximum DP of 3 psi):

VALVE SIZE CHART		
Max GPM	VALVE SIZE	CV
7.5	1/2”	4.4
13	3/4”	7.5
24	1”	14
35	1-1/4”	20
48	1-1/2”	28
69	2”	40
113	2-1/2”	65
156	3”	156
294	4”	294

3. Close-off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:
   a) Water Valves:
      (1) Two-way: 150% of total system (pump) head.
      (2) Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.

   b) Steam Valves: 150% of operating (inlet) pressure.

4. Water Valves
   a) Body and trim style and materials shall be in accordance with manufacturer’s recommendations for design conditions and service shown, with equal percentage ports for modulating service.

   b) Sizing Criteria.
      (1) (**CVT**) Two-position service.
      (2) Two-way modulating service: Pressure drop shall be equal to twice the pressure drop through heat exchanger (load), 50% of the pressure difference between supply and return mains, or 3 psi, whichever is greater.
      (3) (**CVM, CVZM**) Three-way modulating service: Pressure drop equal to twice the pressure drop through the coil exchanger (load), 3 psi maximum.
      (4) Valves (1/2 in.) through (2 in.) shall be bronze body or cast brass ANSI Class 250, spring-return, PTFE packing, quick opening for two-position service. Two-way valves to have replaceable composition disc or stainless steel ball, 23°F - 250°F.
      (5) Valves (2 1/2 in.) and larger shall be cast iron ANSI Class 125 with guided plug and PTFE packing, globe valve.
      (6) Never provide a controls valve that is less than half the size of the supply line serving that sytem.

   c) Terminal Unit Zone valves shall be sized to meet the control application and they shall be spring return so in the event of a power failure, they will go to full open.

5. Acceptable Manufacturer shall be Belimo; or equal.

D. Binary Temperature Devices (**THL-1)**

1. Low-voltage space thermostat shall be 24 V, bimetal-operated, mercury-switch type, with either adjustable or fixed anticipation heater, concealed setpoint adjustment, 13°C to 30°C (55°F to 85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover. Acceptable Manufacturer shall be Honeywell; or equal.

2. Line-voltage space thermostat shall be bimetal-actuated, open contact type, or bellows-actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listed for electrical rating, concealed setpoint adjustment, 13°C to 30°C (55°F to 85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover. Acceptable Manufacturer shall be Honeywell; or equal.

E. Temperature Sensors (**TSB, TSR, TSD, TSDA)**

1. TSB: Flat plate thermistor room sensor. ACI R2; or equal.

2. TSR: Room sensor with LCD display and setpoint adjustability. ZS Pro-M, Automated Logic; or equal.

3. TSD/TSDA: duct mounted sensor.

4. Temperature sensors shall be RTD or thermistor.
   a) Wireless space sensor component certifications shall include:
      (1) UL 916 - Energy Management Equipment.
      (2) UL 94 - The Standard for Flammability of Plastic Materials for Parts in Devices and Appliances.
      (3) UL 873 - Temperature regulating and indicating equipment.
   b) The wireless space sensor battery life shall provide at least 15 years life under normal operating conditions and must be readily available size AA, 1.5V.

5. Duct sensors shall be single point or averaging as shown. Averaging sensors shall be a minimum of 1.5 m (5 ft) in length per 1 m2 (10 ft2) of duct cross section.

6. Immersion sensors shall be provided with a separable stainless steel well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed. The well must withstand the flow velocities in the pipe.

7. Space sensors shall be equipped with setpoint adjustment, override, display, and/or communication port as shown on plans.

8. Provide matched temperature sensors for differential temperature measurement.

F. Humidity Sensors (**HSTS-wall mount / HSP-duct mount**)

1. Space Humidity Sensors shall have a sensing range of 20% to 80% with accuracy of +/- 2% RH.

2. Duct Sensors and Outdoor air humidity sensors shall have a sensing range of 20% to 95% RH with an accuracy of +/- 2% RH.

3. Humidity sensor’s drift shall not exceed 1% of full scale per year.

4. Acceptable Manufacturer shall be Omega; or equal.

G. End Switch (ES-1)

1. Proof of closure of damper. Kele; or equal.

H. Pressure Sensors (**DPT-1)**

1. Air pressure of differential pressure measurements in the range of 0 to 10" water column shall be accurate to +/- 1% of range. Acceptable Manufacturer shall be Setra; or equal.

2. Liquid pressure or differential liquid pressure measurements shall be accurate to +/- 0.25% of range. Unit shall be provided with isolation and bypass manifold for startup and maintenance operations. Acceptable Manufacturer shall be Setra; or equal.

I. Low Limit Thermostats (**LC-1)**

1. Safety low limit thermostats shall be vapor pressure type with an element 6m [20 ft] minimum length. Element shall respond to the lowest temperature sensed by any one foot section. Acceptable Manufacturer shall be Honeywell; or equal.

2. Low limit shall be manual reset only.

J. Carbon Dioxide Sensors (**CDS-1)**

1. Carbon Dioxide sensors shall measure CO2 in PPM in a range of 0-2000 ppm. Accuracy shall be +/- 3% of reading with stability within 5% over 5 years. Sensors shall be duct or space mounted as indicated in the sequence of operation.

2. Acceptable Manufacturer shall be Dwyer; or equal.

K. Flow Switches (**FS-1)**

1. Flow-proving switches shall be either paddle or differential pressure type.

2. Paddle type switches (water service only) shall be UL listed, SPDT snap-acting with pilot duty rating (125VA minimum) and shall have adjustable sensitivity with NEMA 1 enclosure unless otherwise specified. Manufacturer shall be Setra; or equal.

3. Differential pressure type switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 1 enclosure, with scale range and differential suitable for intended application or as specified. Acceptable Manufacturer shall be Setra; or equal.

L. Air Flow Probes (**AF-1)**

1. Provide an array of airflow traverse probes where indicated, capable of continuously monitoring the fan or duct capacities (CFM) they serve. Each airflow traverse probe shall contain multiple total and static pressure sensors located along the exterior surface of the cylindrical probe and internally connected to their respective averaging manifolds. The flow sensors shall not protrude beyond the surface of the probe(s), and shall be the offset type for static pressure and the chamfered impact type for total pressure measurement. The airflow sensing probe's measurement accuracy shall not be affected by directional flow having pitch and/or yaw angles up to 30°. Each airflow traverse probe shall be of extruded aluminum construction and furnished with mounting plate(s), gasket and signal fittings suitable for HVAC duct installation.

2. The airflow traverse probe shall not induce a pressure drop in excess of 0.03" w.c. at 2000 FPM, nor measurably contribute to sound levels within the duct. Total and static pressure sensors shall be located at the centers of equal areas (for rectangular duct) or at equal concentric area centers (for circular ducts) along the probe length. The airflow traverse probe shall be capable of producing steady, non-pulsating signals of total and static pressure without need for flow corrections or factors, with an accuracy of 2-3% of actual flow, over a velocity range of 400 to 4000 FPM.

3. Provide the minimum number of probes indicated: Duct height 8 – 12", 1 probe; 13 – 30", 2 probes; 31 – 54", 3 probes; 55 – 84", 4 probes; 85 – 120", 5 probes; 121 – 180", 6 probes.

4. The airflow traverse probe shall be the VOLU-probe as manufactured by Air Monitor Corporation, or equivalent.

M. Hydronic Flow Meters (**FM-3**)

1. Insertion-Type Turbine Meter
   a) Insertion type, complete with hot-tap isolation valves to enable sensor removal without water supply system shutdown.

   b) Liquide flow measurement devices shall be accurate to +/- 1% over a turn down ratio of 10:1.

   c) Each sensor shall be individually calibrated and tagged accordingly against the manufacturer's primary standards.

   d) All wetted metal parts shall be constructed of 316 stainless steel.

   e) Analog outputs shall consist of non-interactive zero and span adjustments, a DC linearly of 0.1% of span, voltage output of 0–10 Vdc, and current output of 4–20 mA.

   f) Acceptable Manufacturer shall be Onicon; or equal.

N. Relays (**CR-1)**

1. Control relays shall be UL listed plug-in type with dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage shall be suitable for application.

2. Time delay relays shall be UL listed solidstate plug-in type with adjustable time delay. Delay shall be adjustable ±200% (minimum) from setpoint shown on plans. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure when not installed in local control panel.

3. Acceptable Manufacturer shall be Functional Device Inc;. or equal.

O. Transformers and Power Supplies

1. Control transformers (**XT-1**) shall be UL listed, Class 2 current-limiting type, or shall be furnished with over-current protection in both primary and secondary circuits for Class 2 service.

2. Unit output shall match the required output current and voltage requirements. Current output shall allow for a 50% safety factor. Output ripple shall be 3.0 mV maximum Peak-to-Peak. Regulation shall be 0.10% line and load combined, with 50 microsecond response time for 50% load changes. Unit shall have built-in over-voltage protection.

3. Unit shall be UL recognized.

4. Acceptable Manufacturer shall be Functional Device Inc.; or equal.

P. Current Switches (**CFS-1)**

1. Current-operated switches shall be self-powered, solid state with adjustable trip current. The switches shall be selected to match the current of the application and output requirements of the DDC system.

2. Acceptable Manufacturer shall be Functional Device Inc.; or equal.

Q. Immersion Temperature Sensor (**ITS, ITS-1)**

1. Furnish with brass thermowell. Well insertion length to center of pipe. Glycol system require stainless steel well. ACI; or equal.

R. Motion Detector (**MDS-1**)

1. Ultra- sonic type omni directional transmitter, dual receivers, sensitivity gain control, 600 sq. ft. coverage, 24 Volt DC, Universal Energy Control Inc.; or approved equal.

S. Static Pressure Sensor (**SPS-1, SPNL-1)**

1. Model 264, pressure transmitter 4-20mA, 0-5VDC, 2.5VDC bidirectional output, 24VDC power by this Contractor, range 0-1.0" wg. or as applicable to individual systems needs. Setra; or approved equal.

T. Current transmitters

1. AC current transmitters shall be the self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4 to 20 mA two-wire output. Unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A full scale, with internal zero and span adjustment and ±1% full-scale accuracy at 500 ohm maximum burden.

2. Transmitter shall meet or exceed ANSI/ISA S50.1 requirement and shall be UL/CSA recognized.

3. Unit shall be split-core type for clamp-on installation on existing wiring.

4. Acceptable Manufacturer shall be Functional Device Inc. or equal.

U. Power Monitors

1. Selectable rate pulse output for kWh reading, 4–20 mA output for kW reading, N.O. alarm contact, and ability to operate with 5.0 amp current inputs or 0–0.33 volt inputs.

2. 1.0% full-scale true RMS power accuracy, +0.5 Hz, voltage input range 120–600V, and auto range select.

3. Under voltage/phase monitor circuitry.

4. NEMA 1 enclosure.

5. Current transformers having a 0.5% FS accuracy, 600 VAC isolation voltage with 0 - 0.33 V output. If 0–5 A current transformers are provided, a three-phase disconnect/ shorting switch assembly is required.

6. Acceptable Manufacturer shall be Allen-Bradley; or equal.

V. Push Button (**PB-1)**

1. Flush mount, stainless steel plate, mushroom head, contact block with red nameplate, white lettering to identify fan and purpose.

W. Thermal Energy Meters

1. Matched RTD or thermistor temperature sensors with a differential temperature accuracy of ±0.15°F.

2. Flow meter that is accurate within ±1% at calibrated typical flow rate and does not exceed ±2% of actual reading over an extended 50:1 turndown range.

3. Unit accuracy of ±1%

4. NEMA 1 enclosure.

5. UL listed.

6. Isolated 4–20 ma signals for energy rate and supply and return temperatures and flow.

7. Acceptable Manufacturer shall be Onicon; or equal.

X. Carbon Monoxide Sensor (**CDS-1**)

1. Wall mounted Carbon Monoxide Sensor (CO) shall monitor CO over a range of 0-300 PPM.

2. The device shall have an accuracy of +/- 3% and operate within the range of 32-110 deg F and 0-95% RH.

3. Acceptable Manufacturer shall be Honeywell; or equal.

Y. Local Control Panels (**TCP, TCP-1)**

1. All indoor control cabinets shall be fully enclosed NEMA 1 Type construction with hinged door, and removable sub-panels or electrical sub-assemblies.

2. Interconnections between internal and face-mounted devices shall be pre-wired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600-volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.

3. Provide on/off power switch with over-current protection for control power sources to each local panel.

PART 3 – EXECUTION

3.01 EXAMINATION

A. The Contract Documents shall be thoroughly examined for coordination of control devices, their installation, wiring, and commissioning. Coordinate and review mechanical equipment specifications, locations, and identify any discrepancies, conflicts, or omissions that shall be reported to the Architect/Engineer for resolution before rough-in work is started.

B. The BAS manufacturer shall inspect the jobsite in order to verify that control equipment can be installed as required, and any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.

3.02 PROTECTION

A. The BAS installation contractor shall protect all work and material from damage by their work or personnel, and shall be liable for all damage thus caused.

B. The BAS manufacturer shall be responsible for their work and equipment until final inspection, testing, and acceptance. The BAS installing contractor shall protect their work against theft or damage, and shall carefully store material and equipment received on site that is not immediately installed. The Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.03 COORDINATION

A. Site

1. Where the mechanical work will be installed in close proximity to, or will interfere with, work of other trades, the contractor shall assist in working out space conditions to make a satisfactory adjustment. If the contractor installs his/her work before coordinating with other trades, so as to cause any interference with work of other trades, the contractor shall make the necessary changes in his/her work to correct the condition without extra charge.

2. Coordinate and schedule work with all other work in the same area, or with work that is dependent upon other work, to facilitate mutual progress.

B. Submittals. Refer to the “Submittals,” section of this specification for requirements.

C. Test and Balance

1. The contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.

2. The contractor shall provide training in the use of these tools. This training will be planned for a duration of 4 hours.

3. The tools used during the test and balance process shall be returned to the contractor at the completion of the testing and balancing.

D. Life Safety

1. Duct smoke detectors required for air handler shutdown shall be supplied under Divison 26 contract. The contractor shall interlock smoke detectors to air handlers for shutdown as described in the Sequences of Operation for this project.

E. Coordination with Controls Specified in Other Sections or Divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. These controls shall be integrated into the system and coordinated by the contractor as follows:

1. All communication media and equipment shall be provided as specified in the “Communication” section of this specification.

2. Each supplier of a controls product is responsible for the configuration, programming, start-up, and testing of that product to meet the sequences of operation described in this section.

3. The Contractor shall coordinate and resolve any incompatibility issues that arise between the control products provided under this section and those provided under other sections or divisions of this specification.

F. Fire Alarm: Provide interface card to allow communications between temperature control network and fire alarm system. Coordinate exact requirements with Electrical Contractor. Provide all hardware and software necessary for full seamless interface. Show fire alarm failure on graphics.

3.04 GENERAL WORKMANSHIP

A. Install equipment, piping, wiring/conduit, parallel to building lines (i.e. horizontal, vertical, and parallel to walls) wherever possible.

B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

C. Install all equipment in readily accessible locations as defined by National Electric Code (NEC). Control panels shall be attached to structural walls or properly supported in a free-standing configuration, unless mounted in equipment enclosure specifically designed for that purpose. Panels shall be mounted to allow for unobstructed access for service.

D. Verify integrity of all control wiring to ensure continuity and freedom from shorts and grounds prior to commencing the startup and commissioning procedures.

E. All control device installation and wiring shall comply with Contract Documents, acceptable industry specifications, and industry standards for performance, reliability, and compatibility. Installation and wiring shall be executed in strict adherence to local codes and standard practices referenced in Contract Documents.

3.05 FIELD QUALITY CONTROL

A. All work, materials, and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in Contract Documents.

B. BAS manufacturer shall continually monitor the field installation for building code compliance and quality of workmanship. All visible piping and or wiring runs shall be installed parallel to building lines and properly supported.

C. BAS installing Contractor(s) shall arrange for field inspections by local and/or state authorities having jurisdiction over the wor.

3.06 WIRING

A. All control and interlock wiring shall comply with the National, Local Electrical Codes, and Divison 26 of these Contract Document specifications.

B. All NEC Class 1 (line voltage) wiring shall be UL Listed in approved raceway according to NEC requirements.

C. All wiring in plenum spaces shall be enclosed in conduit. Plenum rated cable can be used in accessible ceilings.

D. Where Class 2 wires are in concealed and accessible locations; including ceiling return air plenums, approved cables outside of electrical raceway can be used provided that the following conditions are met:

1. Circuits meet NEC Class 2 (current-limited) requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit.)

2. All cables shall be UL listed for application (i.e., cables used in ceiling plenums shall be UL listed specifically for that purpose).

3. Line Voltage Control Wiring:
   a) For control relays or other low amperage circuits #14 AWG THHN.

   b) For direct line voltage control of equipment minimum conductor size #12 AWG THHN.

   c) Electronic Sensor Wiring: 18 AWG, stranded (16x30) copper conductors, twisted pair, 100% overall aluminum polyester shield, 20 AWG CU drain wire. Polyethylene insulation, PVC jacket, 300V, 60°C. Furnish Belden; or equal.

   d) Computer Communications Cable: 18 AWG, stranded (16x30) copper conductors, (2) twisted pair, 100% individual aluminum polyester shields each shield with 20 AWG CU drain wire. PVC insulated, PVC jacket, 300V. Furnish Belden; or equal. Note: Actual # of conductors may be increased as required for actual communication requirement.

4. Provide minimum (1) spare shielded twisted pair conductors in each communications wiring run. Wiring runs between operator work stations (if any) provide (2) spare shielded twisted pair conductors.

E. Do not install Class 2 wiring in conduits containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two via control relays and transformers.

F. Where Class 2 wiring is run exposed, wiring shall be conduit

G. Maximum allowable voltage for control wiring shall be 120Vac. If only higher voltages are available for use, the BAS manufacturer shall provide step-down transformers to achieve the desired control voltages.

H. All control wiring shall be installed as continuous lengths, where possible. Any required splices shall be made only within an approved junction box or other approved protective device.

I. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations in accordance with Contract Documents and National and/or Local Codes.

J. Conduit and wire sizing shall be determined by the BAS manufacturer in order to maintain manufacturer's recommendation and meet National and Local Codes.

K. Conduit Routing and termination

1. Conduits shall be installed so as to be concealed in all finished spaces at the conclusion of the project unless otherwise noted. Conduits may be exposed in mechanical and electrical rooms and unfinished storage, maintenance and production areas.

2. Where it is impractical to conceal wiring or conduit in finished construction, cables shall be run in wiremold.

3. Make neat runs parallel or perpendicular to structural elements (walls, ceilings, floors) of building with minimum number of couplings and bends. Install so that required conductors may be drawn without injury or excessive strain.

4. Provide double locknuts and insulation bushings on the end of each conduit entering an enclosure. If smaller holes are used in knockouts provide listed devices which overlap largest knockouts as required to strengthen the termination.

5. Cap or plug open ends of conduits during construction.

6. Conduits shall be continuous from equipment controls to cabinets, junction or pull boxes and shall enter and be secured to all boxes in such a manner that each system shall be electrically continuous.

7. Change in Direction of Conduit:
   a) Concealed locations - use standard radius bend.

   b) Exposed locations or concealed locations where conduit will be accessible; use standard radius bends or conduit body.

8. Install conduits to allow proper drainage. Do not form pockets.

9. Securely attach all conduits to building structure utilizing approved methods and fastening devices for support.

10. Clear obstructions in raceways or replace raceways at no additional contract cost. Demonstrate to Architect that spare conduits are free of obstruction at substantial completion and leave a drag line (1/8" polypropylene monofilament utility rope) for future use.

L. Follow manufacturer's installation recommendations for all communication and network bus cabling. Network or communication cabling shall be run separately from all control power wiring.

M. Adhere to the Division 26 requirements for installation of electrical raceways.

N. BAS manufacturer shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.

O. Flexible metal conduits and liquid-tight flexible metal conduits shall not exceed 3' in length and shall be supported at each end. Flexible metal conduit less than 1/2" electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal conduits shall be used.

P. Penetrations:

1. Provide fire stopping for all penetrations used by dedicated BMS conduits and raceways. All other project fire stopping to be by other trade.

2. All openings in the fire proofed or fire stopped components shall be closed by using approved fire resistive sealant.

3. All wiring passing through penetrations, including walls, shall be in conduit or enclosed raceway.

4. Penetrations of floor slabs shall be by core drilling. All penetrations shall be plumb, true and square.

5. No penetrations in structural elements shall be made before receipt of written approval from Engineer and/or Architect.

Q. BMS Raceway:

1. All wiring shall be installed in conduit or raceway except as noted elsewhere in this specification. Minimum control wiring conduit size 3/4".

2. Where it is not possible to conceal raceways in finished locations, surface raceway (wiremold) may be used as approved by the Engineer.

3. All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the surface to which they are attached.

4. Flexible metal conduit shall be used for vibration isolation and shall be limited to 3' in length when terminating to vibrating equipment. Flexible metal conduit may be used within partition walls. Flexible metal conduit shall be UL listed.

3.07 COMMUNICATION WIRING

A. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.

B. Do not install communication wiring in raceway and enclosures containing Class 1 or other Class 2 wiring.

C. Maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer shall not be exceeded during installation.

D. Contractor shall verify the integrity of the entire network following cable installation. Use appropriate test measures for each particular cable.

E. When a cable enters or exits a building, a lighting arrestor must be installed between the line and ground.

F. All runs of communication wiring shall be unspliced length when the length is commercially available.

G. All communication wiring shall be labeled to indicate origin and destination.

3.08 FIBER OPTIC CABLE

A. All cabling shall be installed in a neat and workmanlike manner. Minimum cable and unjacketed fiber bend radii as specified by cable manufacturer shall be maintained.

B. Maximum pulling tensions as specified by the cable manufacturer shall not be exceeded during installation. Post installation residual cable tension shall be within cable manufacturer's specifications.

C. Fiber optic cabinets, hardware, and cable entering the cabinet shall be installed in accordance with manufacturers' instructions. Minimum cable and unjacketed fiber bend radii as specified by cable manufacturer shall be maintained.

3.09 INSTALLATION OF SENSORS

A. Sensors required for mechanical equipment operation shall be factory installed and wired as specified in mechanical equipment specifications. BAS manufacturer shall be responsible for coordinating these control devices and ensuring the sequence of operations will be met. Installation and wiring shall be in accordance with the BAS manufacturer's recommendations.

B. Sensors that require field mounting shall meet the BAS manufacturer’s recommendations and be coordinated with the mechanical equipment they will be associated.

C. Mount sensors rigidly and adequately for the environment the sensor will operate.

D. Room temperature sensors shall be installed on concealed junction boxes properly supported by the block wall framing. For installation in dry wall ceilings, the low voltage sensor wiring can be installed exposed and must meet applicable National and Local Electrical Codes.

E. All wires attached to wall mounted sensors shall be sealed off to prevent air from transmitting in the associated conduit and affecting the room sensor readings.

F. Install duct static pressure tap with tube end facing directly down-stream of air flow.

G. Install space static pressure sensor with static sensing probe applicable for space installation where applicable.

H. Sensors used in mixing plenums, and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip.

I. All pipe mounted temperature sensors shall be installed in matched thermowells. Install all liquid temperature sensors with heat conducting fluid in thermal wells for adequate thermal conductance.

J. Wiring for space sensors shall be concealed in building drywall. EMT conduit is acceptable within mechanical equipment and service rooms.

K. Install outdoor air temperature sensors on north wall complete with sun shield at manufacturer’s recommended location and coordinated with Engineer.

3.10 IDENTIFICATION OF HARDWARE AND WIRING

A. All field wiring and cabling, including that within factory mounted, and wired control panels and devices for mechanical equipment, shall be labeled at each end within 2" of termination with a cable identifier and other descriptive information for troubleshooting, maintenance, and service purposes. BAS manufacturer to coordinate this labeling requirement with mechanical equipment manufacturer as it relates to controls.

B. Permanently label or code each point of field terminal strips to show the instrument or item served and correlate them to the BAS design drawings.

C. Identify control panels with plastic nameplates.

3.11 CONTROL SYSTEM CHECKOUT AND TESTING

A. Acceptance Check Sheet:

1. The contractor shall prepare check commissioning sheets that include all points for all functions of each system as indicated on the temperature controls submittal documents.

2. Submit the check sheets to the engineer for aproval within the temperature controls submittal documents.

3. Engineer will use the approved check sheets as the basis for acceptance of the BAS.

4. The contractor is perform complete commissioning reports for this project. Prior to final payment, contractor must submit signed commissioning checklist, approved by both the owner and engineer. The contractor must also prepar commissioning reports for each piece of equipment that is being controlled.

B. Start-up testing. All testing in this section shall be performed by the contractor and shall make up part of the necessary verification of an operating control system. This testing shall be completed before the owner's representative is notified of the system demonstration.

1. The contractor shall furnish all labor and test apparatus required to calibrate and prepare for service all of the instruments, controls, and accessory equipment furnished under this specification.

2. Verify that all control wiring is properly connected and free os all shorts and ground faults. Verify that terminations are tight.

3. Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures according to manufacturer's recommendations.

4. Verify all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starter, etc.) operate properly and normal positions are correct.

5. Verify all analog output devices (I/Ps, actuators, etc) are functional, that startand span are correct, and that direection and normal positions are correct. The contractor shall check all control valves and autoatic dampers to ensure proper action and closure. The contractor shall make any necessary adjustments to valve stem and damper blade travel.

6. Verify the system operation adheres to the sequences of operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops and optimal start/stop routines.

7. Alarms and Interlocks
   a) Check each alarm separately by including an appropriate signal at a value that will trip the alarm.

   b) Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction,

c) Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

C. Start-up testing. All testing in this section shall be performed by the contractor and shall make up part of the necessary verification of an operating control system. This testing shall be completed before the owner’s representative is notified of the system demonstration.

3.12 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

A. Acceptance: The BAS will not be accepted as meeting the requirements of Completion until all tests described in this specification have been performed to the satisfaction of both the Engineer and Owner. Any tests that cannot be performed due to circumstances beyond the control of the Contractor may be exempt from the Completion requirements if stated as such in writing by the Owner's representative. Such tests shall then be performed as part of the warranty.

3.13 TRAINING

A. Provide minimum of 2 classroom training sessions, and 4 hours for each session, throughout the contract period. The training will be provided for personnel designated by the Owner.

B. Provide course outline and materials prior to schedule training session. The instructor(s) shall provide one copy of training material per student.

C. The instructor(s) shall be factory-trained and experienced in teaching this technical material.

END OF SECTION

SECTION 232100 - WATER SYSTEM SPECIALTIES AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawing and General Provisions of contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.02 SUBMITTALS

A. Schedule of all materials used.
B. Product data for all specialties.

1.03 GENERAL REQUIREMENTS

A. All equipment and accessories in this section shall be rated for a least 125 psi wwp, and 250°F minimum temperatures, unless otherwise specified.
B. Manufacturer's written installation procedures shall become a part of these specifications.

PART 2 - PRODUCTS

2.01 WATER SYSTEM SPECIALTIES AND EQUIPMENT

A. AF-1: High capacity air vent; float actuated non-modulating. Positive shut off up to 150 psig and a maximum temp. of 250°F. Cast Iron construction with internal components of Type 313 stainless steel, brass, Buna-N and silicone rubber. Bell & Gossett, Model #107; or equal.

B. AV-1: Air bleed valve, at each high point or air pocket in water piping systems, 1/8" NPT size, brass body, key operated, extension tube if required. 150 working pressure and 225ºF operating temperature. Bell & Gossett Model #4V; or equal.

C. AV-2: Air eliminator 3/4" inlet, normally open, float actuated valve. Cast iron construction with stainless steel float, valve head and float. Provide 3/8" relief tube to 6" AFF. Model #13 W; Spirax Sarco, Inc.; or equal.

D. BFP-1: Backflow preventer, minimum size = 1”, 3/4" NPT connections, bronze body construction with Celcon check seats. Provide bronze strainer and full port bronze ball valves. Watts Regulator Co., Model #909 SQT; or equal.

E. PG-1: Pressure gauge, 0-60 psig range 4-1/2" dial, bottom connection, cast aluminum case, slip ring, phosphor bronze bourdon tube, brass socket, bronze rotary movement, 1% accuracy. Albert A. Weiss & Sons, Inc., Cat. #4PGAN-1; or equal. Pressure gauge shall be installed with shut-off valve pressure pulsation snubber.

F. PSD-1: Angle pattern flow straightening fitting equipped with a combination diffuser-strainer-orifice cylinder, flow straightening vanes, start-up strainer, permanent magnet and adjustable support foot. All internal components shall be replaceable. Armstrong Model #SG43; or equal. Coordinate pump and system connection sizes with drawings.

G. RV-1: Relief valve, water service, refer to drawing for pressure setting, size per capacity of system, minimum 1" size, bronze body and bonnet, brass trim. Furnish Bell and Gossett Model # 1170; or an approved equal.

H. RWCV-1: Radiation Control Valve. Self contained, wireless, modulating temperature control valves for hot water, with remote sensing bulb. 150 psi maximum and 250°F maximum union connections. Danfoss Model #RA-FN with remote sensor Model #RA2000; or equal.

I. SS-1: Pipeline strainer, line size up to 2", screwed cast bronze body, 20 mesh stainless steel screen, for liquid or steam service. S.W.P. 125 lbs at 400°F. Series #777S, Watts Regulator Co.; or equal. Note: Provide ball valve BV-1 and hose connections for blow-down.

J. TH-1: Thermometer, cast aluminum case and adjustable joint, copper plated steel bulb chambers, separable brass socket, range 30°F to 240°F. Weiss Instruments, Inc. Vari-angle, Model #9VS6; or equal.

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

A. All equipment and systems as shown on the drawings or specified herein shall be installed in accordance with the provisions of each applicable section of these specifications.

B. Provide 4" high concrete housekeeping pads where required.

C. Obtain detailed written or graphical instruction from each manufacturer for proper method of installing each piece of equipment.

D. Provide reducers where required to adapt water system specialties to piping system.

E. Provide all supporting steelwork, hangers, and suspension racks as required, and support as approved by Architects.

3.02 SYSTEM FILLING

A. After cleaning, fill each system from low point:

1. With pumps off, vent all mains, risers, runouts, units, etc., working consecutively from low to high point in building. Obtain approximately 2 psi at highest point. Obtain proper air cushion in compression tanks. Vent all released air and gases at all vent points. Check high level in compression tanks; drain if necessary.

3.03 AIR VENTING

A. Provide vents at all points in piping system where air may collect. Provide one of the following:

1. Manual vent assembly consisting of: 1-1/4" x 6" air collection chamber, 1/4" brass globe valve in accessible location, install hose connection to valve outlet.

2. Automatic vent with air chamber.

3.04 EQUIPMENT VENTS

A. When Equipment is Above Mains: Connect runouts or risers to upper quadrant or top of mains. Install vent assembly concealed within enclosure, consisting of 1" diameter by 4" to 6" long air collection chamber with 1/4" soft copper tube to manual valve. Mount securely near bottom of enclosure, but not fastened to enclosure. For individual units, provide screwdriver.

B. When Equipment is Below Mains: Connect piping runouts or risers to bottom or lower quadrant of mains. Vent assembly not required in unit. Provide means of purging and draining each unit, if required. Use tees instead of elbows at low point of runouts.

3.05 STRAINERS

A. Provide approved valved dirt blow-off connection for strainers, size 6" and larger. Equip with quick opening gate valve and brass plug. Valve located 6" to 12" below strainer or as approved, full size of tapping. Provide discharge piping if required for protection, when directed by Architects or shown on plans.

1. Note: strainer to be mounted horizontally.

END OF SECTION

SECTION 232110 - STEAM SYSTEM SPECIALTIES & EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract including the General and Supplementary Conditions and Division 1 Specifications Sections, apply to the work of this section.

1.02 SUBMITTALS

A. All parts, equipment, and piping specialties listed and specified in this section.

B. Submittals shall be marked to identify specified information.

1.03 GENERAL REQUIREMENTS

A. All equipment and accessories in this section shall be rated for at least 125 psi wwp, and 250°F minimum temperatures, unless otherwise specified.

B. Manufacturer's written installation procedures shall become a part of these specifications.

PART 2 - PRODUCTS

2.01 EQUIPMENT

A. PG-2: STEAM PRESSURE GAUGES

1. Pressure gauges shall have a 4” diameter dial with units marked in psig, as appropriate. Pressure ranges 0-300. Gauges installed in steam systems shall be installed with ring type syphon tube and cock or a U type syphon tube and cock. Bourdon tube gauge constructed in accordance with DIN 16005. Spirax Sarco or approved equal.

2. Ring syphon shall be an ASTM A-106 Gr. A, seamless steel.

3. Gauges shall be stainless steel or mild steel. Dry gauges shall have special dampening agent, performing as a liquid-filled gauge. Pressure gauge accuracy is 1½%. Spirax Sarco or approved equal.

4. Gauges shall be located to minimize the effects of vibration, extreme ambient temperatures and moisture. Gauges shall not be moved between different applications without written approval from the Engineer or Designee. Refer to ASME B40.1.

5. To prevent live steam from entering the bourdon tube, a siphon filled with water shall be installed between the gauge and the process steam.

6. If freezing of the condensate in the loop of the siphon is a possibility, a diaphragm seal shall be used to isolate the gauge for the process steam. Heat tracing and insulation of the siphon is also an acceptable option with approval from the Engineer or Designee.

7. Pressure gauges have a standard vent plug and should be used in an indoor dry environment.

8. Pressure gauges shall be sized for full-scale pressure range such that the operating pressure occurs in the middle of half of the scale (12 o'clock position desirable). The maximum operating pressure shall not exceed 80% of the full pressure range of the gauge.

B. **SSS-1: Cast Iron Y Pattern Strainers.**

1. Body: ASTM A 126, Class B cast iron, with bolted cover, for 2½ inch (DN 65) and larger.

2. End Connections: Threaded ends for strainers 3 inch (DN 80) and smaller; flanged ends for strainers 2 inch (DN 50) and larger.

3. In "Strainer Screen" sub-paragraph below, the larger mesh numbers have larger passages, thus allowing larger objects to pass.

4. Strainer Screen: steam use: stainless steel, 60/100 mesh to suit application.

5. Strainer Screen: liquid: 3" and less: 20 mesh. 4" and above $^{1}/_{8}$" perforation.

6. Tapped blow off plug.

7. Maximum allowable saturated steam pressure rating: 250 psig or flange rating whichever is less.

8. Spirax Sarco model IT, CI-125, CI-250

C. **VB-1: VACUUM BREAKERS**

1. Vacuum breakers shall have a Brass or Stainless Steel body, hardened ball check valve design with all working parts manufactured from stainless steel.
2. In open loop steam systems, vacuum breakers on modulating or on/off heat exchangers and coils shall be installed in the supply side between the control valve and equipment.
3. Vacuum breakers shall be mounted at the highest point of the circuit.
4. Large coils or equipment may require more than one vacuum breaker to be fitted.
5. Vacuum breakers shall be installed in a vertical position with cap at top.
6. On packaged heat transfer and condensate pump skids vacuum breaker should be installed as directed by skid manufacturer.

7. Spirax Sarco Model VB14, VB21

2.02 STEAM TRAPS

A. **STF-1: Float and Thermostatic Traps**

1. Float and thermostatic traps shall have cast iron bodies or SG ductile iron bodies and covers to 200 psig) operating pressures or cast steel bodies and covers to 465 psig operating pressures. Traps shall be line repairable without disturbing the connecting piping. All internals including float, main valve head and seat, and thermostatic air vent shall be stainless steel. Air vent shall be of a precision welded twin diaphragm design, which is completely encased in a protective capsule, and is self-adjusting over its entire operating range. Air vent capsule shall be a stainless steel balance pressure thermostatic air vent capable of withstanding 572ºF superheat steam temperature and resisting water hammer without sustaining damage. Internals of the trap shall be completely serviceable without disturbing the piping.

2. Float and Thermostatic traps for drip and/or process applications (under 200 psig) shall be SG ductile or Cast Iron and have either parallel or inline threaded connections.

3. SPIRAX SARCO MODELS FTI, FT, FTB, IFT OR FT14

B. STT-1: Thermodynamic Traps

1. Thermodynamic traps shall have tight shut-off with no steam loss allowed either by bleed or “controlled leak” and shall have an integral seat design with hardened disc and seating surfaces.

2. Thermodynamic traps for low and medium pressure drip, tracer or process applications shall be of all stainless steel or carbon steel construction with threaded socket weld or flanged connections on a common center line, and will operate in any position, although horizontal is preferred. Traps to be capable of operating with up to 80% back pressure and shall be standard with insulating cover to reduce excessive heat loss resulting from low ambient temperatures, wind, rain, etc. on all TD52, TD42 and TD62 series models. When supplied with an integral strainer a hand wheel or wrench operated blow-down valve, to keep the operator clear of the blow-down stream, shall be available as an option on some models. ***SPIRAX SARCO MODELS TD52 or TD52L,***

C. **STBP-1: Balanced Pressure Thermostatic Traps**

1. Balanced Pressure Thermostatic Traps shall be self-adjusting over the full operating range of the trap. All elements shall be either multiple plate bellows or capsule enclosed diaphragm of precision welded stainless steel with hardened stainless steel valve head. Internals shall be renewable without disturbing the piping.

2. Radiator traps shall operate from 25” Hg vacuum to 125 psig. Brass body, stainless steel seat and element replaceable in line. Trap shall discharge at 23°F below saturation temperature. Angle pattern traps with standard inlet spud or extended spud to meet legacy trap dimensions.

3. SPIRAX SARCO MODEL RTA-125, RTH-125, RTV-125

PART 3 - EXECUTION

3.01 GENERAL

A. All equipment and systems as shown on the drawings or specified herein shall be installed in accordance with the provisions of each applicable section of these specifications.

B. Obtain detailed written or graphical instruction from each manufacturer for proper method of installing each piece of equipment.

C. Provide all supporting steelwork, hangers, and suspension racks for all equipment as required, and support as approved by Engineer.

END OF SECTION

SECTION 232113 - PIPING SYSTEMS AND ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary conditions and Division 1 Specification Sections, apply to work of this section.

1.02 SUBMITTALS

A. Schedule of pipe and fittings.
B. Product data for all materials.
C. Test reports.

1.03 REFERENCE STANDARDS AND CODES

A. All installations and materials shall conform to applicable 2016 New York State Building code, and local building and plumbing codes.

B. All piping shall be inspected and approved by Underwriters Laboratories and bear the UL label.

C. All installations shall conform to requirements of Owner's Insurance carriers.

D. Refer to the latest edition and applicable sections of the following:

1. American Society of Testing and Materials (ASTM)

2. American National Standards Institute (ANSI)

3. American Society of Mechanical Engineering (ASME)

4. Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.

5. Boiler and Pressure Vessel Code, Section VIII, Division 1 - Pressure.

6. Boiler and Pressure Vessel Code, Section IV, Heating Boilers.

7. Code for Pressure Piping B31.9 - Building Services Piping.

8. American Welding Society (AWS).

9. National Fire Protection Association (NFPA)

10. National Electrical Manufacturer's Association (NEMA)

11. "Maximum allowable natural gas pressure: gas pressures within boiler rooms shall not exceed a maximum of 2 psig; gas pressures within buildings (other than boiler rooms) shall not exceed a maximum of 0.5 psig."

1.04 GENERAL REQUIREMENTS

A. All materials furnished and all installations made under this specification shall conform with the applicable requirements of the codes and standards described herein.

B. Layout of equipment, piping, etc. is diagrammatic, unless detailed. Check project drawings prior to making installations for interference's with other trades and services. Owner reserves the right to make reasonable changes prior to "rough-in" without added expense. All dimensions shown are subject to verification of exact site conditions.

C. Have any required local or municipal inspection processed and present to Owner with certificate indicating approval of such governing body.

D. Furnish and install all brackets, anchors, sleeves, seals and/or supports as required for the HVAC installations. Where detail is not shown, submit shop drawings of intended construction for approval.

E. All work to be performed in cooperation with the Owner. Coordinate construction schedule with the Owner. Report delays in material receipt immediately to Owner indicating full circumstances concerning delay.

F. Piping systems shall be presented to the Owner complete, in perfect working order, tested in full accordance with the Contract Documents. All work associated with the installations shall be guaranteed in complete accordance with the Contract Documents.

G. Perform all testing as required and as specified herein.

PART 2 - PRODUCTS

2.01 PIPE

A. Heating Hot Water (2" & Below):

1. Type L, seamless hard drawn temper copper tube, ASTM B-88; wrought copper socket fittings, unions, ANSI B16.22; threaded valve connections, solder joints shall be 95-5 tin to antimony solder, conforming to ASTM B-32.

2. Type L, seamless hard drawn temper copper tube, ASTM B-88; unions, ANSI B16.22. For use with mechanically joined fittings.

B. Heating Hot Water (2-1/2" & Larger):

1. Black steel pipe, seamless or ERW, Schedule 40 with beveled ends, ASTM A-53, GR.B; steel weld joints and fittings, ASTM A-234; standard weight steel flanged connections to valves and equipment, butt-weld ends, raised facings, 150 lb. rating, ANSI B16.5.

2. Black steel pipe, seamless or ERW, Schedule 40 with beveled ends, ASTM A-53, GR.B; ASTM A-234; standard weight steel flanged connections to valves and equipment, 150 lb. rating, ANSI B16.5. For use with mechanically joined fittings.

C. Low Pressure Steam up to 15 PSI (2" & Below): Black steel pipe, seamless or ERW, Schedule 40, ASTM A-53, GR.B; threaded malleable iron fittings, 150 lb. rating, ANSI B16.3; threaded joints, ANSI B1.20.1; union connections.

D. Low Pressure Steam up to 15 PSI (2-1/2" & Larger): Black steel pipe, seamless or ERW, Schedule 40 with beveled ends, ASTM A-53, GR.B; welded joints and steel fittings, ASTM A-234; standard weight steel flanged connections to valves and equipment, butt-weld ends, raised facings, 150 lb. rating, ANSI B16.5.

E. Steam Condensate (2" & Below): Black steel pipe, seamless, Schedule 80 (XS), ASTM A-53, GR.B; threaded malleable iron fittings, 300 lb. rating; ASTM B16.3; threaded joints, ANSI B1.20.1, union connections.

F. Steam Condensate (2-1/2" & Larger): Black steel pipe, seamless, Schedule 80 (XS), ASTM A-53, GR.B; welded joints, extra heavy (XS) steel weld fittings, 300 lb. rating, ASTM A-234; flanged connections to valves and equipment, butt-weld ends, raised facing, 300 lb. rating, ANSI B16.5.

G. Condensate Drain (1" & Below): Type M, hard drawn copper tube, ASTM B-88; wrought copper socket fittings, unions, ANSI B16.22; solder joints shall be 50/50 tin to lead solder, conforming to ASTM B-32.

H. Condensate Drain (1-1/4" & Larger): Type DWV, hard drawn copper tube, ASTM B-88; wrought copper socket fittings, unions, ANSI B16.22; solder joints shall be 50/50 tin to lead solder, conforming to ASTM B-32.

I. Condensate Neutralizer Drain (All sizes): Schedule 40, chlorinated polyvinyl chloride (CPVC) plastic pipe. ASTM D2846 F441, ASTM F442. Orion Blue Line Flame Retardant or equal.

2.02 FITTINGS

A. 2” and Smaller – Copper Pipe Mechanically Joined Fittings:
1. Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of ASME B16.51 and IAPMO PS 117. Sealing elements shall be factory installed EPDM. Fittings shall be rated for an operating pressure of 200PSI and operating temperature range of 0°F to 250°F
2. Manufacturer shall warranty fittings to be free from failure caused by manufacturing defect for a period of 50 years from date of installation.
3. Fittings shall not be allowed for use in below grade/direct buried application, or exposed outside of building envelope.
4. Fittings shall be Viega ProPress or equal.

B. 2-1/2" and Larger - Steel Pipe Mechanically Joined Fittings:

1. Couplings shall be manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets shall be pressure-responsive synthetic rubber, grade to suit the intended service, conforming to ASTM D-2000. Mechanical Coupling bolts shall be zinc plated (ASTM B-633) heat treated carbon steel track head conforming to ASTM A-449 and ASTM A-183, minimum tensile strength 110,000 psi.
   a) Rigid Type: Victaulic Style 107H / W07. Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1, B31.9, and NFPA 13. Above 12in, coupling keys shall be wedge shaped for increased strength. Installation ready rigid coupling for direct stab installation without field disassembly. Gasket shall be Grade “EHP” EPDM compound with red color code designed for operating temperatures from -30°F to +250°F.
   b) Flexible Type: Victaulic 177N / W77. Use in locations where vibration attenuation and thermal expansion compensation (including risers). Flexible couplings may be used in lieu of flexible connectors at equipment connections. Installation ready flexible coupling for direct stab installation without field disassembly. Gasket shall be Grade “EHP” EPDM compound with red color code designed for operating temperatures from -30°F to +250°F.
   c) Fittings: Cast of ductile iron conforming to ASTM A-536, Grade 65-45-12, provided with an alkyd enamel finish. Factory-fabricated grooved end header all-in-one assembly for fluid distribution, consisting of an ASTM A53, Grade B, standard weight pipe spool with required outlet connections. Grooved ends roll grooved to Victaulic dimensions, with enamel coating.

2.03 IDENTIFICATION

A. Pipe Identification Markers: Furnish and install pipe identification markers on all piping installed under this contract. It shall consist of self-adhesive labels of black letters imprinted on color coded backgrounds indicating pipe fill and direction of flow. Lettering shall be 2" high on pipes 3" diameter and over and 3/4" high on pipes under 3". Markers shall be applied to pipe, or to insulation in case of insulated pipes, on 15' centers and at each valve, whichever is closer. Color code as follows:

	Legend	Background
a)	Steam Supply	Yellow
b)	Steam Condensate	Yellow
c)	Heating Hot Water	Yellow
d)	Condensate Drain	Green
e)	Refrigeration Piping	Green

B. All pipe identification colors shall conform to ANSI Standard A-13.1. Pipe identification markers shall be vinyl cloth, 0.0085" thick, Seton Nameplate Corp., Setmark Type; or equal.

C. Nameplates: Identify each valve, control entity or piece of equipment with stamped brass or engraved plastic nameplate permanently attached by riveting, wiring, etc. Set up complete identification system in cooperation with Owner's Physical Plant/Maintenance Department. Each drain plug or valve shall be tagged "DRAIN". Furnish and install engraved rigid laminated plastic nameplate to identify function of each control item on temperature control panel. Remote operating control switches shall have engraved faceplates to indicate function and/or operation controlled. Embossed and/or pressure sensitive plastic tape labels shall not be acceptable. Furnish engraved 2" x 1" black rigid laminated plastic nameplate for each motor starter furnished for mechanical equipment and present with motor starter to EC for mounting.

2.04 PIPING HANGER SYSTEMS

A. Heating System Pipe Hangers: Furnish cast iron single pipe roll hangers, carbon steel clevis hangers, carbon steel copper plated hanger, as required for proper installation. Furnish C Type beam clamps, carbon steel electro-galvanized continuous threaded rod and accessories as required. Furnish as manufactured by Elcen Metal Products Co., Michigan Hanger Co., Inc.; or an approved equal.

B. Non-Insulated System Pipe Hangers: Furnish clevis ring pipe hanger, carbon steel electro-galvanized finish, Model #401. Furnish steel c-clamps, continuous threaded rod and accessories.

C. Furnish trapeze hanger system in addition or in place of hanger systems above as detailed on drawings.

2.05 TEE CONNECTIONS

A. Two sizes or more smaller than main run in steel pipe, make with Bonney Forge, Inc., Weldolets or Threadolets; or equal. Copper tube run-out piping thus connected to steel mains shall be by means of bronze threaded adapter threaded into Threadolet.

2.06 LIABILITY

A. Contractor shall be held liable throughout guarantee period for any damage from failure of piping due to poor or faulty workmanship and/or defective materials.

2.07 STEEL PIPE HANGERS

A. Horizontal runs of pipe shall be securely held in place by means of suitable hangers. In general, hanger shall be clevis type with threaded rod supports. Chain or cold rolled flat steel straps are not acceptable. Supports shall be spaced according to the following schedule:

	Pipe Size	Maximum Spacing	Minimum Rod Size
1.	3/4 in.	5 ft.	3/8"
2.	1 in.	6 ft.	3/8"
3.	1-1/4 in.	6 ft.	3/8"
4.	1-1/2 in.	8 ft.	3/8"
5.	2 in.	10 ft.	3/8"
6.	2-1/2 in.	11 ft.	1/2"
7.	3 in.	12 ft.	1/2"
8.	4 in.	12 ft.	5/8"
9.	6 in.	10 ft.	3/4"
10.	8 in. and larger	10 ft.	3/4"

B. Heating piping hangers shall be applied directly to piping. Cut-out insulation for hanger and cover with jacketing. Insulation shall be "butt-up" to hanger as tightly as possible.

C. Chilled water pipe insulation shall be continuous and have no breaks, insulation shield shall be applied between insulation and hanger.

D. Where Piping is Supported from Open Web Steel Joists, and Running Perpendicular to the Joists:

1. Reduce the maximum hanger spacing for 8" pipe from 12 feet to 8 feet. Where two 6" or 8" pipes are running side by side, stagger the hangers so only the load from one pipe is applied to a joist. Where two 6" and two 8" pipes are running side by side, reduce the maximum hanger spacing for 6" pipe from 12 feet to 8 feet and for 8" pipe from 12 feet to 6 feet, and stagger the hangers so that no more than one 6" pipe and one 8" pipe are supported from a single joist. Where possible, support from steel beams or girders.

E. Where Piping is Supported from Open Web Steel Joists, and Running Parallel to the Joists:

1. Reduce the maximum hanger spacing for 6" pipe from 12 feet to 10 feet and for 8" pipe from 12 feet to 8 feet. Where two 6" or 8" pipes are running side by side, stagger the hangers so only the load from one pipe is applied to each support location. Where two 6" and two 8" pipes are running side by side or where four 6" inch pipes are running side by side, reduce the maximum hanger spacing for 6" pipe from 12 feet to 8 feet and for 8" pipe from 12 feet to 6 feet, span unistrut supports between at least three joists, and stagger the hangers so that no more than two pipes are supported at each support point. Where possible, support from steel beams or girders.

2.08 COPPER TUBE HANGERS

A. Pipe hangers for copper tube shall be copper plated hanger rings.

2.09 SLEEVES

A. Pipes passing through masonry construction shall be fitted with sleeves. Each horizontal sleeve shall extend through its respective wall and be flush with each surface. Each vertical sleeve shall extend through its respective floor slab, be flush with underside of slab, and extend 1/2" above top of finished slab. Sleeves shall be two pipe sizes larger than uninsulated lines and one pipe size larger than overall diameter of insulated lines.

B. See Section 230005 - HVAC Work General; for penetration requirements through fire rated partitions, walls, floors etc.

2.10 PIPE ENCLOSURES

A. 16 GA metal piping enclosures by Sterling. Provide mounting strip and angle supports. Refer to drawings for three sided vertical (model #PCV) two sided vertical (model #PCV) or horizontal (model #PCH) enclosures. Color selection by architect.

VERTICAL PIPE ENCLOSURE

PIPE SIZE (IN)	NUMBER OF PIPES	INSULATION THICKNESS	PIPE ENCLOSURE SIZE (IN)
3/4	2	1-1/2	10x5
1	2	1-1/2	10x5
1-1/4	2	1-1/2	10x5
1-1/2	2	2	12x6
2	2	2	14x8
2-1/2	2	2	16x8
3	2	2	16x10
4	2	2	18x10
6	2	2	20x12

PART 3 - EXECUTION

3.01 GENERAL PIPE INSTALLATION

A. The following shall describe methods of assembly to be followed in the installations of piping by the Contractor:

1. All pipe shall be clean and free of internal mill scale, dirt, etc. before installation.

2. All pipe shall be cut accurately to measurements established at the building and shall be worked into place without springing or forcing except where specifically called for. All pipe shall be out of the way of all windows, doors and other building openings or structural parts. All pipe shall be so installed that it can expand and contract freely without damage to any other portions of the work or to itself. All pipe, after having been cut, shall be reamed so as to present full pipe size. All changes in direction shall be made with proper pipe fittings. All pipe shall be installed approximately as indicated upon the plans and as specified. Piping connections to pieces of equipment shall be in accordance with the details shown on the plans or as specified. All open ends of pipe or equipment shall be properly capped or plugged during the installation in order to keep dirt and foreign matter out of the system.

3. Run-outs and branches from mains to units above the mains shall be taken from the top of the main and sloped up to the units. Run-outs and/or branches for heating units below the mains shall be taken from the bottom of the main and sloped down to the units, except where specifically noted.

4. All changes in supply main size shall be made with eccentric fittings arranged so as not to pocket entrained air.

5. All changes in directions of pipe lines shall be made with proper welding fittings for welded pipe and proper screwed joint fittings for screwed pipe and proper soldering fittings for soldered or brazed tube connections.

3.02 EQUIPMENT AND SYSTEMS

A. All equipment and systems as shown on the drawings or specified herein shall be installed in accordance with the provisions of each applicable section of these specifications and all local and state codes and regulations having jurisdiction.

B. All installations shall be performed in a workmanlike manner as determined by the Architects or Owner.

C. Accurately establish grade and elevation of all piping before setting sleeves. Arrange piping at equipment with necessary offsets, unions, flanges, valves, to allow for each part removal and maintenance, as approved.

D. Pitch steam condensate and drain piping to allow for proper drainage.

E. Offset piping and change elevation as required to coordinate with all other trades.

F. Avoid contact with any part of other mechanical or electrical systems.

G. Provide adequate means of draining and venting all units, risers, circuits and systems.

H. Conceal all piping unless otherwise specified.

I. Cap or plug equipment and pipe openings during construction. Install piping parallel with lines of building, properly spaced to provide clearance for insulation.

J. Provide trap seal of adequate depth in overflow line on each drain pan installation.

K. All cleanout plugs, bushings and nipples, required for gauge and instrument installation shall be brass.

L. Do not install valves, unions and flanges in inaccessible locations.

M. Materials used within a system and between systems shall be consistent. If this is not possible, install approved dielectric fittings.

N. Ream pipes after cutting and clean before installing.

O. Refer to Specification Section 232100 - Water Systems Specialties & Equipment; for water system fill requirements.

3.03 FABRICATION AND CONNECTIONS

A. Area of interior welding/soldering shall be ventilated. Personnel shall use respirator protection in accordance with OSHA if ventilation cannot be accomplished during welding/soldering operations in the field.

B. Fabrication methods as specified in Pipe & Fittings Products, shall be as follows:

C. Welding:

1. Contractor shall provide welders who are qualified to Section IX of the ASME Boiler and Pressure Vessel Code.

2. All welds shall conform and be inspected in accordance with ASME B31.9 pressure piping.

3. Comply, with Section II, Part C. ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.

4. Welding can be electric arc or oxy-acetylene and shall present a complete fusion of the weld metal and parent metals for the full depth and/or thickness of adjacent butted parent metals and for the complete circumference.

5. Weld and fabrication sequence shall be arranged to avoid distortion or damage to piping and fittings. Cutting of pipe shall be done to achieve straight lines and squared surfaces.

D. Flanged Connections:

1. Flanged joints shall be carefully aligned and flange bolts, nuts and fastener bearing surfaces shall be lubricated with a heavy graphite oil mixture.

2. Initial tightening of flange bolts shall be 1/2 of the final torque and shall be tightened in a proper sequence pattern. Final tightening shall be uniform with each bolt pulling the same load. Bolts shall be re-tightened 24 hours after final tightening. Torque values shall be in accordance with industrial standards.

3. Furnish gasket material, thickness and type suitable for fluid to be handled, and design temperatures and pressures.

E. Soft Solder Joints - 95/5: Thoroughly clean, apply flux, heat mating parts and apply solder to flow over and form a complete bond of mating parts. Remove excess solder and hold each joint rigid and still until completely cooled. Soft solder shall be 95% tin - 5% antimony, Mueller Brass Co., #95; or equal. Bring soldering flux on job in 2 oz. cans only and keep sealed when not in use.

F. Screw Joints: Shall be made with standard taper pipe threads, properly cut and made up with "permatex", or equal, pipe dope applied to male ends. The use of teflon type tape shall not be permitted.

G. Grooved Connections: Pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. A Victaulic factory trained representative (direct employee) shall provide on-site training for contractor’s field personnel in the use of grooving tools, application of groove, and product installation. All groove depths shall be checked manually or by grooving tool (RG5200i). A Victaulic representative shall periodically visit the job site and review installation.

H. Mechanical Press Fittings: Pipe ends shall be cut on a right angle (square) to the tube. Pipe ends shall be reamed and chamfered, all grease, oil or dirt shall be removed from the tube end with a clean rag. Visually examine the fitting sealing element to ensure there is no damage, and it is properly seated into the fitting. Insert tube fully into the fitting. Make a mark with a felt tip pen on the pipe at the face of the fitting. Always examine the tube to insure it is fully inserted into the fitting prior to pressing the joint. Utilize manufacturer’s recommended tool(s) to make final connection. Sealing elements shall be verified for the intended use. Installers shall attend manufacturer’s installation training class prior to start of work.

3.04 TESTING

A. Preparation and testing shall be in accordance with ASME B31.9.

B. Refer to Specification Section 230593 - Testing, Adjusting and Balancing; for adjusting and balancing of systems.

C. Preparation:

1. Leave joints including welds uninsulated and exposed for examination during the test.
2. Provide temporary restraints for expansion joints which cannot sustain the reactions due to test pressure. If temporary restraints are not practical, isolate expansion joints from testing.

3. Flush system with clean water. Clean strainers.

4. Isolate equipment that is not to be subjected to the test pressure from the piping. If a valve is used to isolate the equipment, its closure shall be capable of sealing against the test pressure without damage to the valve. Flanged joints at which blinds are inserted to isolate equipment need not be tested.

5. Install relief valve set at a pressure no more than 1/3 higher than the test pressure, to protect against damage by expansion of liquid or other source of over-pressure during the test.

D. Hydrostatic Testing (Hydronic Systems):

1. Use ambient temperature water as the testing medium, except where there is a risk of damage due to freezing. Another liquid may be used if it is safe for workmen and compatible with the piping system components.

2. Use vents installed at high points in the system to release trapped air while filling the system. Use drains installed at low points for complete removal of the liquid.

3. Examine system to see that equipment and components that cannot withstand test pressures are properly isolated. Examine test equipment to ensure that it is tight and that low pressure filling lines are disconnected.

4. Subject piping system to a hydrostatic test pressure which at every point in the system is not less than 100 psi or 1.5 times the design pressure. The test pressure shall not exceed the maximum pressure for any vessel, pump, valve or other component in the system under test. Make a check to verify the stress due to pressure at the bottom of vertical runs does not exceed either 90% of specified minimum yield strength, or 1.7 times the "SE" value in Appendix A of ASME B31.9, Code for Pressure Piping, Building Services Piping.

5. After the hydrostatic test pressure has been applied for at least 2 hours, examine piping, joints and connections for leakage. Eliminate leaks by tightening, repairing or replacing components as appropriate and repeat hydrostatic test until there are no leaks.

6. Clean and flush hydronic piping systems. Remove, clean and replace strainer screens. After cleaning and flushing hydronic piping system, but before balancing, remove disposable fine mesh strainers in pump suction diffusers.

E. Pressure Testing and Inspection - General:

1. Prior to acceptance and initial operation, all piping installations shall be inspected and tested to determine that the materials, design, fabrication and installation practices comply with Code Requirements.

2. Inspection shall consist of visual examination, during or after manufacture, fabrication, assembly or pressure tests as appropriate. Supplementary types of non-destructive inspection techniques, such as magnetic-particle, radiographic, ultrasonic, etc. shall not be required unless specifically listed herein or in the engineering design.

3. In the event repairs or additions are made following pressure test, the affected piping shall be tested, except that, in the case of minor repairs or additions, testing shall be permitted to be omitted where precautionary measures are taken to ensure sound construction.

4. Because it is sometimes necessary to divide a piping system into test sections and install test heads, connecting piping and other necessary appurtenances for testing, it is not required that the tie-in sections of pipe be pressure tested. Tie-in connections, however, shall be tested with soap solution after gas has been introduced and the pressure has been increased sufficiently to give some indications should leaks exist.

F. Test Preparation:

1. Pipe joints, including welds, shall be left exposed for examination during the test. If the pipe end joints have been previously tested in accordance with Code Requirements, they shall be permitted to be covered or concealed.

2. Equipment that is not to be included in the test shall be either disconnected from the piping or isolated by blanks, blind flanges, or caps. Flanged joints at which blinds are inserted to blank off other equipment during the test shall not be required to be tested.

3. Where the piping system is connected to equipment or components designed for operating pressures of less than the test pressure, such equipment or equipment components shall be isolated from the piping system by disconnecting them and capping the outlet(s).

G. Test Pressure:

1. Test pressure shall be measured with a manometer or with a pressure measuring device designed and calibrated to read, record, or indicate a pressure loss due to leakage during the pressure test period. The source of pressure shall be isolated before the pressure tests are made.

2. The test pressure to be used shall be no less than 1-1/2 times the proposed maximum working pressure, but not less than 3 psig (20 kPa gauge), irrespective of design pressure. Where the test pressure exceeds 125 psig (862 kPa gauge), the test pressure shall not exceed a value that produces a hoop stress in the piping greater than 50 percent of the specified minimum yield strength of the pipe.

3. Test duration shall be not less than 1/2 hour for each 500 cubic feet of pipe volume or fraction thereof. When testing a system having a volume less than 10 cubic feet, the test duration shall be permitted to be reduced to 10 minutes. For piping systems having a volume of more than 24,000 cubic feet, the duration of the test shall not be required to exceed 24 hours.

H. Detection of Leaks and Defects:

1. The piping system shall withstand the test pressure specified without showing any evidence of leakage or other defects. Any reduction of test pressures as indicated by pressure gauges shall be deemed to indicate the presence of a leak unless such reduction can be readily attributed to some other cause.

2. The leakage shall be located by means of an approved combustible gas detector, soap and water, or an equivalent non-flammable solution. Matches, candles, open flames, or other methods that could provide a source of ignition shall not be used.

3. CAUTION: Since some leak test solutions, including soap and water, may cause corrosion or stress cracking, the piping shall be rinsed with water after testing, unless it has been determined the leak test solution is non-corrosive.

4. Where leakage or other defects are located, the affected portion of the piping system shall be repaired or replaced and re-tested.

I. Test Records: Records shall be made of inspection and all tests performed. These records shall indicate which portions of the piping system conform to Code Requirements or were pressure tested.

END OF SECTION

SECTION 232115 - INITIAL FILL & CLEANING (ALL HYDRONIC SYSTEMS)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including the General and Supplementary Conditions and Division 1 Specification Sections, apply to the work of this section.

1.02 RELATED SECTIONS

A. 232500 - Chemical Water Treatment
B. 235000 - Boil-Out Boiler Commissioning
C. 230593 - Testing, Adjusting and Balancing

1.03 SUBMITTALS

A. Product data.
B. A written report is to be completed as specified in Part 3.

PART 2 - PRODUCTS

2.01 GENERAL

A. Trisodium phosphate or other cleaning agent.

PART 3 - EXECUTION

3.01 FILLING & FLUSHING

A. Contractor to install hose assemblies in pipe loop prior to unit installation.

B. Connect hose assemblies directly from supply to return piping (where each unit is to be located) to allow circulation through entire loop for thorough flushing.

C. Fill system with clean, fresh water and properly vent.

D. Hydrostatically test the system to check for leaks and fix any leaks as soon as discovered.

E. Position valves to bypass heat rejecter and supplementary water heater. Start both pumps to circulate water through system.

F. Check strainers often and clean as needed.

G. Continue flushing, using the system pumps, until water coming out of the pipe loop to open the drain has become clear. NOTE: Insure that make-up water is added fast enough to replace what is being flushed out.

H. Flush system for at least two (2) hours until the water is clear and debris flushed out.

I. Remove temporary filter in suction diffuser at pump.

3.02 CLEANING

A. NOTE: BOIL-OUT MUST BE COMPLETED BEFORE PROCEEDING WITH SYSTEM CLEANING, SEE SECTION 235000.

B. Fill system with fresh water and add a cleaning agent such as trisodium phosphate (TSP).

C. Adjust bypass valves at head rejecter and supplementary water heater to normal operation position.

D. Disconnect power to heat rejecter and air conditioners so they will not operate while system is being cleaned.

E. Circulate the cleaning solution through the system, with water heater controls temporarily adjusted to raise the solution temperature to 105°F - 110°F. NOTE: DO NOT raise temperature above 110°F.

F. Alternate operation of primary and standby pumps and circulate solution for several hours.

G. Turn off water heater and pump, completely drain system and refill with fresh water.

H. If there is any indication of debris in system or if tested water is slightly acid, the cleaning process must be repeated (The pH must be between 7.0 and 8.0).

I. Install hose assemblies.

J. Adjust flow control valves in the return lines to establish the proper GPM. System balancing is to be accomplished prior to start-up of the equipment.

K. Field services shall be provided by a factory trained representative to fully set-up and adjust the units, after the installations have been completed and before the units are placed in service. Written start-up report to be furnished. Factory alignment, lubrication, three phase motor rotation, etc. shall all be completed and checked before pumps are placed in service.

L. Provide written report to Architect stating that all steps of filling, flushing and cleaning of system have been fully completed. Also include test results to insure that water pH is between 7.0 and 8.0.

3.03 HYDRONIC

A. New Systems:

1. Check pre-charge pressure of diaphragm-type expansion tank. This pressure must match system fill pressure (if it does not, follow manufacturer's instructions for pressurizing tank).

2. PRV must be set at same pressure as tank.

3. Close all AV's except high capacity AV (AF-1) in boiler room.

4. Fill system with fresh, clean water until water runs freely from AF-1.

5. Test pH of water: it must be between 7.0 and 8.0.

6. Vent all units, mains, etc. in systems.

7. Hydrostatically test the system for leaks and repair any leaks as soon as discovered.

8. Run pumps with cold water for 20 to 30 minutes.

9. Stop pumps and start boiler burner. Allow boiler water temperature to reach 220°F, then turn off burner. Wait one minute then start pump and let run for 10 minutes. (If any panel radiation is present, allow boiler water to cool to 140°F before starting pump.)

10. Stop pumps and vent system once again.

11. After approximately 30 days of system operation, contractor shall be responsible for blow-down of all main strainers and removal of temporary filter from the suction diffuser.

12. Provide written report to Architect stating tank and system pressure, pH of water and date of strainer blow-downs and filter removal.

B. Existing Systems: In addition to above steps:

1. Make necessary connections of new piping to existing.

2. Re-fill the system by flushing system with clean water until discharge runs clean. Test pH of water; it must be between 7.0 and 8.0.

3. Contractor shall be responsible (to the owner's satisfaction) for replacing any chemicals, inhibitors, glycol, etc. lost in the connection process.

4. Vent new and existing systems.

5. Hydrostatically test new and existing systems, and insure that any discovered leaks will be repaired. Special attention is required to insure that there is no leakage from existing valves, AV's or other equipment. Contractor shall be responsible for replacing ceilings or other surfaces damaged by leaks from existing systems.

6. If Contractor discovers severely degraded piping, he shall immediately notify the Architect, in writing.

7. After the system has been operating for 30 days, Contractor is responsible for blow-down of main strainers.

8. Provide written report to Architect stating the completion of above procedure and dates of completion.

END OF SECTION

SECTION 232300 - REFRIGERATION PIPING & SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract including the General and Supplementary Conditions and Division 1 Specification Sections, apply to the work of this section.

1.02 SUBMITTALS

A. Product data for all piping and specialties.

1.03 REFERENCE STANDARDS AND CODES

A. All installations and materials shall conform to applicable 2016 New York State Building Code, and local building and plumbing codes.

B. All piping shall be inspected and approved by Underwriters Laboratories and bear the UL label.

C. All installations shall conform to requirements of Owner's Insurance carriers.

D. Refer to the latest edition and applicable sections of the following:

1. American Society of Testing and Materials (ASTM)

2. American National Standards Institute (ANSI)

3. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

4. Piping shall conform to ASHRAE 15 Standards.

5. American Welding Society (AWS).

6. American Refrigerant Institute (ARI).

7. Underwriters Laboratories (UL).

8. American Society of Mechanical Engineers (ASME), Code for Pressure Piping B31.5 - Refrigerant Piping.

1.04 GENERAL REQUIREMENTS

A. All materials furnished and all installations made under this specification shall conform with the applicable requirements of the codes and standards described herein.

B. Layout of equipment, piping, etc. is diagrammatic, unless detailed. Check project drawings prior to making installations for interference's with other trades and services. Owner reserves the right to make reasonable changes prior to "rough-in" without added expense. All dimensions shown are subject to verification of exact site conditions.

PART 2 - PRODUCTS

2.01 PIPE AND FITTINGS

A. Refrigerant Piping (7/8" & Below): Type K, seamless soft temper ACR copper tubing coils, ASTM B-280, factory cleaned with ends capped; flare type threaded fittings, flared tube ends.

B. Refrigerant Piping (1" & Above): Type L, seamless hard temper ACR copper tube, ASTM B-88; wrought copper socket fittings, ANSI B16.22; silver brazing joints, with minimum 3 CFM nitrogen purge.

2.02 REFRIGERATION SPECIALTIES

A. Refrigerant piping specialties shall be UL listed and designed to conform to ARI Standard 760.

B. MF-1: Flexible connector for refrigerant service, size as indicated on drawings, suitable for use on ACR tubing, corrugated phosphorus bronze tube, bronze braid, braid sleeves, end fittings shall be copper female solder type. Unit shall be cleaned and dried for refrigerant service and shipped sealed. Furnish compressor connector, Flexonics Co.; or equal.

C. RSS-1: Refrigerant pipeline strainer; 500 psig maximum working pressure; forged brass body with monel 80-mesh screen and screwed cleanout plug; Y-pattern, with solder end connections.

D. Sight Glass: (Moisture/liquid indicators); 500 psig maximum operation pressure, 200°F maximum operation temperature; forged brass body, with replaceable polished optical viewing window and solder end connections.

E. Filter Dryer: 500 psig maximum operation pressure; steel shell, flange ring and spring, ductile iron cover plate with steel cap-screws and wrought copper fittings for solder end connections. Furnish complete with replaceable filter-dryer core kit of standard capacity desiccant sieves to provide micronic filtration, including gaskets.

F. LLS: Liquid line solenoid valve; 250°F temperature rating, 400 psig working pressure, forged brass , with Teflon valve seat, two-way straight through pattern and solder end connections. Provide manual operator to open valve. Furnish complete with NEMA 1 solenoid enclosure with 1/2" conduit adapter, and 24 Volt, 60 Hertz normally closed holding coil.

G. TXV: Thermal expansion valves; thermostatic adjustable, modulating type; size as required for specific evaporator requirements and factory set for proper evaporator superheat requirements. Valves shall have copper fittings for solder connections; complete with sensing bulb, a distributor having a side connection for hot gas bypass line and an external equalizer line.

H. HGBV: Hot gas bypass valve; adjustable type, sized to provide capacity reduction beyond the last step of compressor unloading and wrought copper fittings for solder end connections.

I. EPRV: Evaporator pressure regulating valves; pilot-operated, forged brass or cast bronze; complete with pilot operator, stainless steel bottom spring, pressure gauge tappings, 24 Volts DC, 50/60 Hertz, standard coil and wrought copper fittings for solder end connections.

2.03 LIABILITY

A. Contractor shall be held liable throughout guarantee period for any damage from failure of piping and accessories due to poor or faulty workmanship and/or defective materials.

PART 3 - EXECUTION

3.01 GENERAL

A. Install all specialties in accordance with requirements for refrigerant piping as recommended by the condenser manufacturer. Refer to Specifications Sections 238115 - Air Cooled Condensing Units and 238110 - Packaged Air Conditioning Units.

B. Refer to Specification section 232113 - Piping Systems and Accessories; for pipe identification, nameplates, hangers and general pipe installation.

3.02 FABRICATION

A. Area of interior brazing shall be ventilated. Personnel shall use respirator protection in accordance with OSHA standards if ventilation cannot be accomplished during operations in the field.

B. Silver Alloy Brazed Joints - in accordance with AWS A5.8, Class BAg1, shall be prepared and made up in complete conformity with the instructions of the brazing alloy and flux manufacturer and shall include complete and thorough cleaning of the mating parts after which an even coating of flux shall be applied to the mating parts. The mating shall be assembled, held rigid and heat applied evenly by oxy-acetylene torch to the complete areas to be joined after which silver alloy shall be flowed into the joint. Silver brazing alloy flux shall be low silver content (15%), melting at 1185°F and free flowing at 1300°F, suitable for joints between copper, brass and bronze. Silver brazing alloy flux shall be specifically for low temperature silver brazing alloy, free flowing at 1100°F. Silver brazing alloy flux shall be Handy & Harman, "Handy-Flux"; or an approved equal. Silver brazing alloy flux shall be brought on the job in only one pound containers and shall be kept sealed when not in use. Silver brazing alloy shall be Handy & Harman, "Sil-Fos"; or an approved equal.

3.03 TESTING AND SYSTEM FILLING

A. Examine rough-in for refrigeration piping systems to verify actual locations of piping connections prior to installation.

B. Install piping free of sags or bends with ample space between piping to permit proper insulation applications.

C. Inspect, test and perform corrective action of refrigerant piping in accordance with ASME Code B31.5, Chapter IV.

D. Repair leaking joints using new materials and retest for leaks.

E. Charge system using the following procedures:

1. Install core in filter dryer after leak test but before evacuation.
2. Evacuate refrigeration system with vacuum pump; until temperature of 35°F is indicated on vacuum dehydration indicator.
3. During evacuation apply heat to pockets, elbows and low spots in piping.
4. Maintain vacuum on system for minimum of 5 hours after closing valve between vacuum pump and system.
5. Break vacuum with refrigeration gas, allow pressure to build up to 2 psi.
6. Complete charging of system using new filter dryer core in charging line. Provide full operating charge.

END OF SECTION

SECTION 233300 - DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including the General and Supplementary Conditions and Division 1 Specification Sections, apply to the work of this section.

1.02 SUBMITTALS

A. Schedule of all components.
B. Product data sheets on all equipment.
C. Submit shop drawings on all equipment. Include all performance and dimensional data.

1.03 GENERAL REQUIREMENTS

A. All control dampers shall have published performance data taken from test made in accordance with AMCA Standard 500 and in compliance with the AMCA certified ratings program for air performance and air leakage performance.

B. All fire dampers shall be rated for 1-1/2 hrs (unless specifically noted otherwise) under UL Standard 555 and shall meet NFPA 90A construction requirements.

C. Backdraft dampers shall have performance data published under the guidelines of AMCA and conform to all safety standards as set forth by NFPA 90A.

PART 2 - PRODUCTS

2.01 VOLUME DAMPERS

A. Provide where indicated on drawings or required to control air flow, for air balancing, size as required, manually operated.

B. For Rectangular Ducts up to 12" Max Dimension: Single blade volume damper for use by air balancing contractor. Damper may be fabricated by sheetmetal contractor. Damper blade shall be fabricated from stiff material and be free from operating noise. Ensure sufficient clearance between damper blade and duct wall to prevent noise. Provide external position indication and locking quadrant.

C. For Rectangular Ducts Over 12": Furnish and install where indicated on drawings, size as required, manually operated, opposed blade damper, 16 ga. galvanized steel construction, concealed linkage, with manual locking quadrant. Model #VCD-20, Greenheck Fan Corporation; or equal.

D. For Round Ducts: When volume damper is not an integral part of branch connection, furnish and install where indicated, size as required, manually operated, round air balancing damper, galvanized steel construction with manual locking quadrant. Model VCDR-53, Greenheck Fan Corporation.

E. BD-1: Backdraft damper, nonmetallic type with blades constructed of neoprene coated fiberglass. Extruded aluminum channel. Model #BD51, Pottorff Mfg.; or an approved equal. Don’t have a vinyl blade damper.

F. BD-2: Counter balanced backdraft damper, constructed of 75 aluminum blades with neoprene blade seal and steel axles will ride on ball bearing. Model #EM-30, Greenheck Fan Corporation.

G. CD-1: Control damper, aluminum construction, parallel blade, Oilite Bronze bearings, Stainless steel jamb seals and vinyl blade seals, stainless steel linkage. Model #VCD-43, Greenheck Fan Corporation.

2.02 REMOTE CONTROL DAMPER REGULATORS

A. RC-1: Concealed damper regulator, ceiling installation, embedded in the finished ceiling so unit is flushed with finished surface. Cover plate shall be 2-5/8". Finish shall be cadmium. Ceiling remote controller shall be Young Regulator Co., #301-HRS-3/8" with coupling; or equal. Furnish OBD control damper, Model #820A-C for operation from ceiling regulator, as manufactured by Young Regulator Company.

B. RC-2: Round Duct: Furnish remote control circular damper, #850, as manufactured by Young Regulator Co.; or an approved equal. Furnish corner pulleys, union connectors, compression fittings and brass tubing, quantity as required. Furnish remote operator, #700-SM.

1. Rectangular Duct: Furnish remote control OBD, extruded aluminum construction, Model #830A, as manufactured by Young Regulator Company; or an approved equal. Furnish with corner pulleys, compression fittings, union connectors, brass tubing and cable all as required for complete and proper installation. Furnish operator Model #700-SM, for surface mounting, Type "C" indicator dial, as manufactured by Young Regulator Company; or an approved equal.

2.03 FIRE DAMPERS

A. FRD-A: Fire dampers used in transfer air sleeves between adjacent rooms above ceilings, UL listed 1-1/2 hour rating. Nailor Industries Model #0110 or equal.

B. FRD-B: Fire dampers shall be manufactured, tested and labeled in accordance with UL 555 Safety Standard for Fire Dampers - Sixth Edition, June 1999, and shall have 1-1/2 hour fire resistance rating. Each fire damper shall bear a UL label verifying fire resistance rating in addition to intended mounting position. Fire dampers shall be suitably constructed for vertical or horizontal installation as required for each specific location. Each fire damper shall be complete with a 165°F (74°C) UL Listed fusible link. Fire dampers shall each include a steel sleeve of appropriate length/gauge and retaining angles, supplied by damper manufacturer to ensure proper installation in accordance with damper manufacturer's instructions. Damper to have blades out of air steam. Contractor shall provide and install an access door at each fire damper, of appropriate size to allow for inspection, testing and fusible link replacement. Information submitted for approval shall include confirmation of UL qualifications, pressure drop data and manufacturer's installation instructions. Fire dampers shall be Nailor Industries Models 0120 (Type B), or equal. Use Model 0130V or 0130H for round ducts.

C. FRD-S: Provide fire/smoke dampers where indicated on drawings. UL 555S classified Class II leakage rating at 250 degrees and UL 555 listed 1-1/2 hour labeled. Nailor Model # 1270ERL with min. 16" long 20 gauge sleeve and 120 volt electric actuator, with actuator out of airstream, and 165ºF heat responsive device. Contractor shall provide and install an access door at each fire damper, of appropriate size to allow for inspection and testing. Electrical contractor shall furnish smoke detector to heating contractor – heating contractor to install within 5'-0" of damper. Install detector per manufacturer's recommendations and requirements.

2.04 DUCT ACCESS DOORS

A. Furnish and install where indicated on plans and/or required for access to life safety dampers, control probes, etc.; galvanized door with manual lock(s), double wall, 1" internal fiberglass insulation, galvanized steel frame, foam gasket seal, minimum 24 gauge construction. Label each access door at fire dampers with "Fire Damper" in letters no less than 1/2" high.

1. Hinged Type: Model #H-10, Buckley Air Products
2. Double Latch Type: Model #C-10, Buckley Air Products

2.05 ARCHITECTURAL ACCESS DOORS

A. Ceiling/Wall Access Door: door and frame for use in existing ceiling or walls. Door and frame fabricated from galvanized steel, thickness as scheduled, with rounded edges and concealed pivoting rod hinge. Frame shall be one piece construction with no miters or welds exposed on face. Door shall include screw driver type latch mechanism.

B. For Existing Ceilings: Provide concealed 1-1/2"x 1-1/2" support angles to be used as a sub-structure to support door frame above existing ceiling.

C. For Fire Rated Doors: Doors shall be UL Listed for fire rated service as scheduled. Door shall include heavy duty spring closer.

Tag	**AD**	**ADF**
Model #	BNTC 24x24	BIT 24x24
Manufacturer	Babcock-Davis	
Fire Rating (hours)	None	1.5
Fire Rating Label	None	B
Steel Thickness	16 gauge	16 gauge
Size (inches)	24x24	24x24
Weight (lbs)	16	24.5
Latches (Qty)	3	1
Notes	(1)(2)	(1)(2)

Notes:
(1) Finish factory prime coat, contractor shall field paint white to match ceiling where located.
(2) Contractor shall verify actual size prior to ordering if required to fit actual ceiling tile arrangement, size may be adjusted to 22x22. However, no gaps are to be allowed from door frame flange and adjacent existing ceiling tiles around perimeter.

2.06 CODE REQUIREMENTS

A. All work shall be in accordance with all applicable codes including NFPA 90A, 90B, and SMACNA requirements.

PART 3 - EXECUTION

3.01 GENERAL

A. Install all equipment in strict accordance with manufacturer's instructions.

3.02 DAMPERS

A. Contractor to furnish all required hardware to complete installation of air split damper and regulator.

B. Provide access doors for dampers not accessible from grilles.

C. Dampers shall be installed so as not to cause stress or strain on the frames. Fasteners shall not interfere with proper operation of blades or linkages.

D. Lubricate and thoroughly clean all moving parts according to the manufacturer's recommendations before initial operation.

E. Seal all seams.

F. Make all necessary adjustments to linkages to insure dampers open fully and close tightly over full stroke of actuator.

G. Replace any damaged parts including blades, seals, linkages, etc.

H. Install automatic vent damper in strict accordance with manufacturer's instructions and NFPA 54.

END OF SECTION

SECTION 233310 - DUCTWORK HANGERS & SUPPORTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specifications Sections apply to work of this section.

1.02 SUBMITTALS

A. See Section 233330 for submittal requirements.

1.03 WORK INCLUDED

A. Contractor shall provide all hangers and supports for all ductwork and air system equipment and accessories.

B. Contractor shall field verify and coordinate all ductwork hangers and supports, dimensions, clearances, and ductwork elevations with new and existing building structure.

1.04 RELATED WORK SPECIFIED ELSEWHERE

A. Section 233330 - Low Velocity Ductwork

B. Section 230713 - Duct Insulation

1.05 QUALITY ASSURANCE

A. SMACNA Manual: Methods of supporting ductwork shall be in accordance with the SMACNA Manual, Section 1 - Low Velocity Systems", unless otherwise shown on the drawings or specified herein.

B. SMACNA - Sheetmetal and Air Conditioning Contractors National Association, Inc.

C. Electrically operated and power actuated tools for installing welded studs and power driven fasteners shall be listed by a nationally recognized test agency.

PART 2 - PRODUCTS

2.01 DUCT HANGERS

A. All Hangers Shall Be Rod Type Hangers: Mild carbon steel, unless otherwise specified; fully threaded or threaded each end, with (2) removable nuts each end for positioning and locking rod in place. Unless galvanized or cadmium plated, provide a shop coat of red lead or zinc chromate primer paint.

B. Hangers for ducts shall be as specified in the SMACNA Manual, with the following exceptions:

1. Lower hanger attachments for rectangular duct with any dimension 18" and above shall be trapeze hangers, supported by threaded rods (3/8" dia. min.).

2. Trapeze hangers shall be minimum 1-1/2" x 1-1/2" x 1/4" angle or larger size as required by larger or heavier ductwork. Ductmate trapeze hanger size AS and AT is acceptable.

3. Lower hanger attachments for rectangular duct with maximum dimension less than 18" may be flat strap attached directly to duct. Fasteners penetrating ducts must be completely sealed.

4. Wire used as supports or as banding shall not be acceptable.

5. Fasteners used on hanger system shall not penetrate supported ductwork. (Exception: Flat strap hangers, see above.)

6. Threaded support rods shall utilize sufficient support, jamb, and lock nuts to allow adjustment of duct heights.

2.02 MISCELLANEOUS FASTENERS AND UPPER HANGER ATTACHMENTS

A. Machine Bolts and Nuts: Galvanized or cadmium plated steel.

B. Steel "C" Clamp with Locknut: Elcen Co.; No. 29L, with 25B steel retaining clips.

C. Structural Aluminum Shapes and Aluminum Plates.

D. Structural Steel Shapes and Steel Plates: ASTM A-36, shop primed.

E. Self Drilling Expanding Fasteners: Phillips type.

2.03 BRANCH FITTINGS, JOINTS & TURNING VANES

A. Provide supports necessary for lengths over 16" or heights over 8".

PART 3 - EXECUTION

3.01 UPPER HANGER ATTACHMENTS

A. General Notes: Upper hanger attachments for ductwork shall be secured to overhead structural steel or steel bar joists wherever possible, unless otherwise specified.

B. In addition, when required by ductwork support spacing schedules, provide intermediate structural steel members, framed to span the structural steel or steel bar joists. The minimum size of structural steel members, for use as intermediate steel framing, shall be 2-1/2" x 2-1/2" x 1/4" steel angles. Intermediate steel members shall be shop prime coated prior to installation. Intermediate steel will be sized for span and load to show no deflection.

C. Secure upper hanger attachments to bar joists at the panel points of joists.

D. Do not drill holes in main structural steel members.

E. Exercise extreme care in the field drilling of holes in precast or pre-stressed concrete work, so as to avoid damage to reinforcing. Power driven types of fastening devices shall have be utilized in the attachment of hangers to precast or pre-stressed concrete work.

F. Upper hanger attachments shall be as specified in the Manual, with the following exceptions:

1. Do not use flat bar, bent rod, power actuated drive pins or expansion nails as upper hanger attachments in concrete construction.

G. Attachment to Structural Steel: Secure to steel beams with beam clamps, welded studs, power actuated fasteners, or "C" clamps with lock nuts and minimum 1/8"x1" wide safety bars.

H. Do not use power actuated fasteners except by written permission from the Engineer's Representative.

I. Do not attach welded studs or powder actuated fasteners to steel less than 3/16" in thickness.

J. Do not use power drive on beam clamps.

K. Attachment to New Poured Concrete Construction: Support hangers from concrete insets. Properly locate and install concrete inserts in concrete form work as required, in ample time so as not to delay the construction work. Bolt band iron hangers to inserts with 3/8" bolts. Screw rods into proper size inserts and secure with lock nuts and washers.

L. Attachment to Cellular Steel or Fluted Metal Decks: Do not support ductwork from cellular steel or fluted metal roof decks. Attach hangers to structural steel members wherever possible, and where required intermediate structural steel supporting members shall be provided, framed to span the structural steel.

M. For attachment to overhead cellular steel or fluted metal decking, other than roof decks, hangers may be attached by means of welded studs with double nuts. The maximum load on any one stud shall be 250 lbs**. UNDER NO CIRCUMSTANCES SHALL UPPER ATTACHMENTS PENETRATE STEEL DECKING, OR ROOF DECK.**

N. Riser Supports: Support vertical rectangular ducts by means of two steel angles or channels, anchor bolted to floor slab or adjacent structural member at every floor through which the riser passes. Steel angles or channels shall contact a transverse joint and be secured to the joints by means of 1/8" bolts, or by welding.

O. Steel angle or channel support sizes shall be as follows:

Max. Side Dimension	Support Angle	Support Channel	Bear on Concrete or Structural Support
36"	1"x1"x1/8"	1"x1/2"x1/8"	2"
48"	1-1/2"x1-1/2"x1/8"	1-1/2"x3/4"x1/8"	3"
60"	2"x2"x1/8"	2"x1"x1/8"	3"
Over 60"	2-1/2"x2-1/2"x3/16"	2"x1"x3/16"	4"

3.02 DUCT HANGER SPACING

A. The duct hanging method must be in accordance with this specification and is subject to Engineer's approval.

B. Duct hanger spacing shall be in strict accordance with SMACNA and as follows:

1. Rectangular Duct Hangers Min. Sizes:

Max. Half of Duct Perimeter	Rod Pair at 10'Spacing	Rod Pair at 8'Spacing	Rod Pair at 6'Spacing	Rod Pair at 4'Spacing
Up to 72	1/4"	1/4"	1/4"	1/4"
73 to 96	3/8"	1/4"	1/4"	1/4"
97 to 120	3/8"	3/8"	1/4"	1/4"
121 to 168	1/2"	3/8"	3/8"	3/8"
169 to 192	1/2"	1/2"	3/8"	3/8"
Above	SEE SMACNA FOR SPECIAL CONDITIONS			

2. Round Duct Hanger Strap Sizes:

Duct Diameter	Strap Hangers	Max. Spacing
Up to 26"	One 1" x 22 Ga.	12 Ft.
27" - 36"	One 1" x 18 Ga.	12 Ft.
37" - 50"	One 1" x 16 Ga.	12 Ft.
51" - 60"	Two 1" x 18 Ga.	12 Ft.

See SMACNA, Table 5-3 for allowable loading for trapeze angles.

END OF SECTION

SECTION 233330 - LOW VELOCITY DUCTWORK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specifications Sections, apply to work of this section.

1.02 SUBMITTAL

A. Layouts of duct systems shown on contract drawings are diagrammatic. Actual duct layout and fabrication shop drawings are required to be submitted for approval. Coordinate these shop drawings with other trades and existing conditions, as required for proper installation, prior to submittal.

B. Please note that ductwork CAD files will not be given to the contractor. Contractor is expected to field verify and draw all ductwork.

C. General duct layout, 3/8" = 1'-0" scale, of all duct systems, including dimensions and elevations.

D. Ductwork shop drawings shall be fabrication drawings, showing actual intended location of ductwork and clearances. Ductwork elevations and architect's ceiling heights shall be noted on drawings.

E. All areas where ductwork is below the architect's ceiling height shall be noted and clouded. **FAILURE TO NOTE BOTH BOTTOM OF DUCT ELEVATIONS AND ARCHITECT'S CEILING HEIGHTS WILL BE CAUSE FOR REJECTION.**

F. Duct shop drawings shall show actual existing and/or new structural steel arrangements, and shall be coordinated to properly fit in intended spaces.

G. Sheetmetal contractor shall verify that ductwork layouts are coordinated with all other construction trades which might cause a conflict. This contractor is required to provide copies of duct shop drawings to all applicable contractors for their use in coordination efforts.

H. Immediately notify Engineer if a duct layout conflict is discovered.

I. Submittal packages which do not include all items listed in this section will be considered incomplete and will be returned to the contractor without review.

J. If a significant number of shop drawings are required, individual drawings may be submitted for review. Duct construction booklet must accompany initial submittal or it will be considered incomplete and returned without review.

K. Fabrication of installation of ductwork shall not be permitted unless duct shop drawings and construction booklet are approved by Engineer.

L. Contractor will be required to remove ductwork installed without duct submittals conforming to requirements of this section and approved by the Engineer.

1.03 DUCT CONSTRUCTION BOOKLET

A. Duct construction booklet shall be submitted with initial duct layout drawing submittal.

B. The following is a basic list of materials, devices, methods, etc. that shall be described in the ductwork construction booklet submittal:

1. Manufacturer's data sheets for all purchased duct accessory components (damper hardware, duct liner, access doors, etc.)
2. Gauges of ductwork, material, method of construction, types of reinforcing and joints, etc.
3. Transverse and Longitudinal Joints
4. Duct Fitting Construction
5. Duct Sealing & Sealants
6. Duct Hangers, Type, Spacing, Upper, Lower
7. Special Supply Air Duct Construction Details (i.e. 14 gauge)
8. Branch Duct Connections Details
9. Acoustic Lining
10. Flexible Ductwork
11. Flexible Connection (to AHU's etc.)
12. Access Doors
13. Duct Accessories
14. Volume Dampers
15. Locking Quadrants
16. Remote Control Damper Regulators
17. Turning Vanes
18. Penetration Trim Frames
19. Fire Damper Installation Details
20. Fire Proofing Penetrations, Chase Safing
21. Specialty Duct Construction and Installation Methods
22. Other Specialty Equipment Connections

1.04 RELATED SUBMITTALS

A. The following shop drawings are required under other specification sections and must be submitted as separate packages (in addition to ductwork submittals detailed in this section).

1. Exhaust Fans
2. Louvers
3. Roof Hoods
4. Diffusers, Registers, Grilles
5. Ductwork Accessories:
   a) Special volume control dampers
   b) Fire and/or smoke dampers
   c) Remote control damper actuators

1.05 WORK REQUIRED

A. Contractor shall furnish materials and labor and shall fabricate and erect all sheetmetal ductwork including connections to units, all dampers, registers, diffusers and accessories as shown on the drawings, described herein and/or as required to make the air handling installations complete.

B. Complete supply and return air ductwork serving all units.

C. All exhaust air ductwork.

D. Relief air ductwork.

E. Ductwork and connection into existing air systems where applicable in existing building.

F. Installation of all intakes and discharges including exhaust fans, louvers, roof hoods.

G. Specialty ductwork and specialty equipment for applicable kitchen, fume exhaust, safety hoods, and other specialty systems where indicated.

H. Modification of existing air system equipment to meet new air system requirements (i.e. - fan drives, belts, sheaves, fan motors, etc.).

I. Complete balancing of all air systems.

J. Contractor shall field verify and coordinate all ductwork, dimensions, clearances, and ductwork elevations with existing building structure.

1.06 RELATED WORK SPECIFIED ELSEWHERE

A. Section 230005 - HVAC Work General
B. Section 230593 - Testing, Adjusting & Balancing
C. Section 230713 - Ductwork Insulation
D. Section 233300 - Ductwork Accessories
E. Section 233310 - Ductwork Hangers & Supports

1.07 QUALITY ASSURANCE

A. SMACNA Manual: Gauges of materials, fabrication and installation of ductwork shall be in accordance with the SMACNA Manual, Section 1 - "Low Velocity Systems", unless otherwise shown on the drawings or specified herein.

B. SMACNA - Sheetmetal and Air Conditioning Contractors National Association, Inc.

C. New York State Energy Code.

D. 2016 New York State Building Code.

E. Electrically operated and power actuated tools for installing welded studs and power driven fasteners shall be listed by a nationally recognized test agency.

1.08 PRODUCT HANDLING

A. Protection: Use all means necessary to protect materials of this Section before, during and after installation and to protect 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 Engineer and at no additional cost to the Owner.

C. Delivery and storage: Deliver all materials to the jobsite in their original unopened containers with all labels intact and legible at time of use. Store in strict accordance with the manufacturer's recommendations.

D. Ductwork that is shop fabricated shall be delivered to the site in quantities acceptable to the storage area that the General Contractor has available.

PART 2 - PRODUCTS

2.01 GENERAL

A. For the purpose of establishing equality, certain manufacturers have been specified herein. In no way shall this be construed as limiting competition. Products of other manufacturer's may be proposed in accordance with the provisions of the Contract.

B. Fabrication: All ducts, unless otherwise allowed, shall be true to dimensions indicated upon plans, straight and smooth on inside, with neatly finished joints. Securely anchor to building construction in acceptable manner, free from vibration under all conditions of operation, and properly brace and reinforce with aluminum angle or other structural members. Slip joints shall be in direction of flow. Elbows shall have centerline radius equal to 1-1/2 times width of duct.

C. **NOTE: ALL DUCTWORK SERVING A VAV SYSTEM SHALL BE RATED FOR 3 IN. W.G. STATIC (POSITIVE OR NEGATIVE) AND SHALL CONFORM TO SMACNA. ALL OTHER DUCTWORK SHALL BE RATED FOR 2 IN. W.G. STATIC (POSITIVE OR NEGATIVE).**

D. All ductwork with a 4 to 1 ratio, and higher shall have a Condu-lock internal reinforcing at midpoint between joints, both horizontally and vertically.

E. All ductwork 10 ft downstream of a VAV to be internally lined, whether shown or not.

2.02 SHEETMETAL

A. Galvanized Steel: ASTM A653/A653M lock forming quality – zinc-coated (galvanized): ASTM A653/A653M commercial coating class – 0.9 oz. per sq. ft.

B. 2" W.G. Low Pressure Rectangular Duct Construction:
1. Note: These gauges are 1 gauge heavier than required by SMACNA.

Longest Side	Gauge	SMACNA Rigid Class (1)	Stiffeners Spacing
0-12"	24	A	5'
13-30"	22	B	5'
31-54"	20	B	5'
55-84"	18	E	5'

C. 2" W.G. Low Pressure Round Duct Construction:

Diameter	Gauge
0-12"	26
13-24"	24
25-36	22

D. Aluminum Ductwork: Use 1 gauge heavier than required by SMACNA Standards.

2.03 LONGITUDINAL JOINTS FOR RECTANGULAR DUCT

A. Seams shall be formed and assembled with proper dimensions for tight and secure fit. Notching shall be minimal consistent with transverse joint requirements.

B. Standard longitudinal seam shall be Pittsburgh Lock Standing seams are not acceptable.

2.04 TRANSVERSE JOINTS FOR RECTANGULAR DUCT

A. Joint type shall be selected on the basis of ± 2" wg. Pressure class, materials, support intervals, and other provisions for proper assembly of ductwork.

B. All transverse joints with any dimension greater than 16" shall be constructed with the Duct Mate system; or an approved equal. All transverse joints 16" and less shall be slip and drive.

C. Contractor shall submit for approval the intended joint type with the duct construction detail book submittal.

D. Turning Vanes and Vane Runners: Weld runners to duct and weld vanes to runners, all as shown on the drawings. All turning vanes shall be air foil type.

2.05 DUCTWORK FITTINGS

A. All elbows on main supply ducts shall be radiused type fittings.

B. Where square elbows are allowed, turning vanes shall be used. Square fittings without turning vanes are not permitted.

2.06 BRANCH CONNECTIONS

A. Furnish and install where indicated on drawings, size as required, the following:

1. For rectangular branch ducts: 45 degree cinch collar, each branch duct to include a volume damper.

2. For round duct branches: High efficiency take-off type fitting with integral volume damper.

3. Branch duct connections regardless of size or type will be fully sealed by an approved method.

2.07 ROUND DUCT CONSTRUCTION

A. Round duct seams shall be spiral lockseam type. Snap lock or lap seams are not acceptable. Duct and fittings shall be single wall Uni-Seal Duct, United McGill Corp.; or equal, unless noted otherwise.

2.08 DUCT SEALING REQUIREMENTS

A. All ductwork, fittings, connections to equipment, damper connections, branch duct connections, and other duct system joints shall be sealed in accordance with the duct system sealing schedule.

B. The term sealed requires the use of liquids, mastics, combination mastics and open weave fabric, gaskets, or other sealing compounds made exclusively for duct work applications. Oil base caulking and glazing compounds shall not be used.

C. Tapes shall not be applied to metal surfaces or to dry sealant.

D. Liquid: As recommended by the manufacturer of the ductwork.

E. Mastic: 3M Co. #ED-800 or 900.

F. Gaskets: Soft neoprene or reinforced inert plastic of the self conforming type.

G. Special Note: All sealants must be applied in ambient temperatures exceeding manufacturer's recommendations to insure proper setup.

H. Seal all penetrations with Manville Pyro-Fiber safing; or equal. Provide safing clips and joint sealant.

2.09 DUCT SYSTEM SEALING SCHEDULE

A. Supply, Return & Exhaust Ductwork: Completely seal all transverse joints and longitudinal seams.

B. Connection to Equipment: Use flanged connections to equipment, provide gasket to seal between flanges. Bent sheetmetal is not acceptable as a flange. Use steel angle or heavy gauge flat bar as a back up surface.

2.10 DUCT LINER

A. Furnish and install where indicated on drawings, acoustic duct liner.

B. Duct liner shall: made from flame attenuated glass fibers bonded with a thermosetting resin, air stream side to be coated with a non abrasive black surface. Furnish 2" thick, permacoat Linacoustic manufactured by Johns Manville; or equal. Duct liner rated for use at 250°F, 5000 fpm, with a k-factor of 0.25 and acoustical performance NRC of 0.70.

C. Ductwork having internal lining is not to be externally insulated, unless otherwise noted.

D. Any lined duct that has had water on the liner, shall be deemed unusable and will be required to be immediately removed from the site. The contractor shall provide an new section at no cost to the owner.

E. Note: Duct sizes shown are net inside duct dimensions, not including internal liner. Failure to comply with this requirement will be grounds for rejection.

2.11 FLEXIBLE DUCTWORK

A. Furnish and install where indicated on drawings, bi-directional reinforced metallized vapor barrier with triple ply stand-up seam; acoustically rated black CPE liner permanently bonded to a coated spring steel wire helix and supporting a thick blanket of fiberglass insulation. UL listed, Class 1 air duct. Flexible Tubing Division, Thermaflex, Type MKE; or equal. For connections to rectangular duct, use Bellmouth fittings with integral volume damper. Flex duct is not to be connected directly to rectangular main ducts. Duct centerline radius to duct diameter ratio not to exceed 1.5. Flex duct to have minimum R-value of 6.0.

B. Maximum length of flexible ductwork not to exceed 8'-0".

2.12 EQUIPMENT CONNECTIONS

A. All equipment shall be connected to ductwork with flexible duct collars.

B. Flexible connection shall be heavy glass fabric, coated with "Durolon", weighing approximately 24 oz. per sq. yard, as manufactured by Duro Dyne Corp.

1. For ducts 30" and below use 3" free length
2. For ducts above 30" use 5" free length.

2.13 TRIM FRAMES

A. Whenever ductwork passes through masonry, furnish and install mitered angle trim frames around ductwork to conceal rough masonry opening.

PART 3 - EXECUTION

3.01 APPLICATION

A. Properly seam, brace, stiffen, support and render ducts mechanically air tight. Where SMACNA plates and/or the specifications indicate duct stiffeners or reinforcing angles, they shall be continuous around all four sides and interlock at corners.

B. Adjust ducts to suit local conditions, and if necessary to accomplish this, dimensions may be changed, as approved, but maintain cross sectional area. Install ductwork so as to provide maximum headroom, unless otherwise noted on the drawings.

C. In addition to having all shop joints in ductwork fabricated in accordance with the Manual, all field joints shall be sealed air tight in accordance with the duct seal schedule.

D. Where turning vanes, balancing damper or any other kind of products are installed, ductwork must be reinforced at all four sides and interlocked at corners.

3.02 FLEXIBLE DUCTWORK CONNECTIONS

A. Flexible connections shall be made with tie straps as made by Panduit; or equal. Straps shall be used to clamp both inner and outer liner to diffuser and branch ductwork. (2) straps are required at each end of flexible ductwork.

3.03 CONNECTIONS TO MISCELLANEOUS DUCT EQUIPMENT

A. All duct connections to duct coils, etc. must be made with smooth transitions in accordance with SMACNA. Duct dimensions specified upstream and downstream (net free area) must be maintained. Sizing ductwork to match miscellaneous equipment is not acceptable, unless design conditions are met.

END OF SECTION

SECTION 233340 - PREFABRICATED DUCTWORK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the contract including the General and Supplementary conditions and Division 1 Specifications Sections apply to the work of this Section.

1.02 SUBMITTALS

A. See Section 233330 for submittal requirements.

1.03 WORK INCLUDED

A. Note: Work in this section shall be in accordance with applicable provisions in Section 233330 - Low Velocity Ductwork.

1.04 RELATED WORK SPECIFIED ELSEWHERE

A. Section 233330 - Low Velocity Ductwork
B. Section 233310 - Duct Hangers and Supports
C. Section 230713 - Ductwork Insulation
D. Section 230593 - Testing, Adjusting and Balancing

1.05 PRODUCT HANDLING

A. Protection: Use all means necessary to protect materials of this Section before, during and after installation and to protect 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 Engineer and at no additional cost to the Owner.

C. Delivery and Storage: Deliver all materials to the jobsite in their original unopened containers with all labels intact and legible at the time of use. Store in strict accordance with the manufacturer's recommendations.

D. Ductwork that is shop fabricated shall be delivered to the site in quantities acceptable to the storage area that the General Contractor has available.

PART 2 - PRODUCTS

2.01 SPECIALTY DUCTWORK

A. Round duct shall be double wall, insulated and acoustically lined. Duct shall have a galvanized steel outer shell of spiral lock seam construction, 1" 1.5lb./ft^3 fiberglass insulation and a perforated steel acoustical liner.

B. Retaining fabric between perforated liner and insulation shall be .008" thick, 15.6 lb./ft^3 density with air permeability rate 9.2 ft^3/SF.S.

C. Duct shall be of a spiral lock seam construction with a mechanically formed seam locking indentation evenly spaced along the spiral seam. All spiral duct 8" diameter and larger shall incorporate multiple corrugations between spiral seams. Duct shall be galvanized steel that conforms to ASTM standards A653 and A924 and be in accordance with SMACNA 2005 Duct Construction Standards and shall conform to SMACNA's HVAC Duct Construction Standards for +10" water gauge pressure. Connection methods shall be slip-fit with all joints being sealed by the installer during the installation process. The type of sealant used as well

as the method and level of application should be in accordance with the sealant manufacturer's published installation instructions and as specified in 233330. All fittings that are either spot-welded or button punched construction are internally sealed. All transitions and divided flow fittings which convert from flat-oval to round 60" diameter or less. Provide 1" lining where indicated on drawing.

D. Schedule for gauge of galvanized steel for outer shell and inner perforated liner:

	Inner Liner Diameter Solid Spiral Wound			
	3"-14"	16"-26"	28"-36"	38"-50"
Duct Outer Pressure Shell	26 ga.	24 ga.	22 ga.	20 ga.
Spiral Wound Inner Liner Duct	26 ga.	26 ga.	26 ga.	24 ga.

E. Ductwork described in this section shall be SPIROsafe double wall as manufactured by Lindab, Inc.; or equal.

2.02 PREFABRICATED DUCTWORK REGISTERS

A. Supply and exhaust registers shall be Lindab's SPIROcomfort for direct mounting on spiral ducts. The register shall be mounted without the use of a rectangular register tap. Top and bottom flanges are to meet flush with spiral duct regardless of duct diameter. Registers shall be 20 or 22 gauge galvanized steel with double deflection adjustable blades and integral volume damper.

2.03 DUCT CONNECTIONS

A. All double wall duct and fittings shall be provided with both an inner liner coupling and an outer pressure shell coupling for all connections.

B. Outer shell connections shall be by flanged joint. Inner liner connections shall be by slip joint couplings for duct to duct connections. Fitting liners shall be extended 2" beyond the outer shell to provide an inner liner coupling for duct to fitting connections.

2.04 HANGING SYSTEM OPTIONS

A. Cable hanging systems (where indicated) with adjustable mechanical devices shall be compliant with SMACNA HVAC Duct Construction Standards Third Edition-2005, are allowed as replacement for threaded rod or strap, for both upper and lower attachments. Cable hangers may be used to suspend round ductwork. Select hangers for the type of structure and suspension, based on load ratings, and end fixings based on deck structure. Crimps shall be factory installed. All cable hanger products shall be certified as SMACNA and UL listed. All parts (including the cable) shall be supplied, warranted and proof tested by the same manufacturer, Gripple; or equal. Follow recommended factory installation guidelines; do not exceed safe working loads.

2.05 FITTINGS

A. Fittings shall also have a galvanized steel shell, 1" fiberglass insulation and perforated steel acoustical linings. Construction of fittings shall be die stamped, gored, pleated or mitered as shown on drawing.

B. All double wall fitting ends shall come factory equipped with a double lipped, u-profile, EPDM rubber gasket. Gasket shall be classified by UL.

C. Fasten ducts and fittings together with self tapping sheetmetal screws or pressure proof pop rivets.

PART 3 - EXECUTION

3.01 GENERAL

A. Installation shall be in accordance with manufacturer’s installation instructions.

END OF SECTION

SECTION 233416 - CENTRIFUGAL FANS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary conditions and Division 1 Specification Sections, apply to work in this section.

1.02 SUBMITTALS

A. Schedule of exhaust fans and all accessories.

B. Sound power ratings.

C. Product data sheets for all equipment.

D. Dimensioned shop drawings.

E. Special Note: Fans sizes may be selected for future capacities. Fan size substitutions which do not meet intended future capacities will not be accepted.

1.03 GENERAL REQUIREMENTS

A. Provide supply, and exhaust fans to fit intended use and location as indicated on plans and/or specified.

B. Capacity, size and arrangement, static pressure, brake horsepower, component parts and accessories as scheduled and/or as necessary to obtain required results and allow for proper maintenance. Motor efficiency shall comply with EISA standards.

C. Ratings based on tests made in strict accordance with current AMCA sound and performance standards including standard #210.

D. Each size fan to be supplied shall be tested in the manufacturer's laboratory under simulated installation conditions. Ratings based on test, not on interpolated or extrapolated calculation.

E. Submit certified performance tests by AMCA for all centrifugal fans 5,000 CFM and larger.

F. Guaranteed full capacity delivery through duct systems finally installed and under conditions listed.

G. Guaranteed sound-power level ratings not exceeding those of design equipment.

H. All equipment statically and dynamically balanced to acceptable tolerances with all weights permanently fastened.

I. When dampers are supplied, furnish all necessary relays and devices to permit operation.

PART 2 - PRODUCTS

2.01 CENTRIFUGAL FANS DESCRIPTION

A. Centrifugal fan belt driven (unless otherwise noted). Fabricated from formed and curved material with continuously welded seams. Provide removable covers or access doors to allow access to internal parts. Drive frame structure constructed of heavy gauge galvanized steel.

B. Drive assembly and wheel shall be removable without disassembly of fan housing. Fan shaft shall be painted to avoid corrosion. Furnish accessory hinging kit to facilitate access to fan internal components and ductwork.

2.02 MOTORS

A. All motors shall be general purpose squirrel-cage induction type, NEMA Design 8, Class 8 insulation, continuous duty, 40°C ambient, single or multiple speed as scheduled.

B. All three phase motors shall be NEMA Premium Efficiency design. Motor efficiency shall be indicated on the motor nameplate by the manufacturer per IEEE Standard 112 Method 8 in accordance with following tables:

Open Drip Proof (ODP)

Horsepower	1200 RPM	1800 RPM	3600RPM
1	82.5%	85.5%	77.0%
1.5	86.5%	86.5%	84.0%
2	87.5%	86.5%	85.5%
3	88.5%	89.5%	85.5%
5	89.5%	89.5%	86.5%
7.5	90.2%	91.0%	88.5%
10	91.7%	91.7%	89.5%
15	91.7%	93.0%	90.2%
20	92.4%	93.0%	91.0%
25	93.0%	93.6%	91.7%
30	93.6%	94.1%	91.7%

Totally Enclosed Fan-Cooled (TEFC)

Horsepower	1200 RPM	1800 RPM	3600 RPM
1	82.5%	85.5%	77.0%
1.5	87.5%	86.5%	84.0%
2	88.5%	86.5%	85.5%
3	89.5%	89.5%	85.5%
5	89.5%	89.5%	86.5%
7.5	91.0%	91.7%	98.5%
10	91.0%	91.7%	90.2%
15	91.7%	92.4%	91.0%
20	91.7%	93.0%	91.0%
25	93.0%	93.6%	91.7%
30	93.0%	93.6%	91.7%

C. Single speed motors shall operate at 1750 RPM unless otherwise indicated.

D. For All Motors with Motor Starters:

1. Provide premium efficiency motor.

2. Fractional HP motors shall be equipped with internal automatic reset thermal overload switch.

3. Provide factory mounted and wired safety disconnect switch; locate in motor compartment. When disconnect will not fit in motor compartment furnish weatherproof NEMA 3R safety switch for external mounting.

E. Motors for Units with Variable Frequency Drives:

1. Motor shall be rated for inverter duty.

2. Provide motor of continuous duty, 1.15 SF, NEMA Class F insulation

3. For fractional horse motors with variable frequency applications provide permanently split capacitor or shaded pole type motor.

4. See Specification Section 238505 - Variable Frequency Drive Systems for further details.

2.03 FAN DRIVE ASSEMBLIES

A. Fan manufacturer shall furnish motors, V-belts and drives complete and ready to operate. Drives shall include the following:

1. Drives rated at 150% of motor horsepower.

2. Motors 5 HP and larger: Minimum of two belts.

3. Use only matched belt sets for multiple drives.

4. Cast iron or cast steel pulleys.

5. Provide test holes in belt guards for speed checks.

6. Provide shaft guards where shafts extend beyond belt guards.

7. Adjustable type motor pulley with 15% speed adjustment above and below rated speed.

8. Drive ratio not over 4:1 except as otherwise approved.

B. For Variable Frequency Applications:

1. Do not use belt drives

2. All variable frequency applications shall utilize direct drive fans.

2.04 FAN BEARINGS

A. Fan manufacturer shall furnish all fans with self-aligning, grease lubricated, ball or spherical roller bearings selected in accordance with rating method of Anti-Friction Bearing Manufacturers' Association, so "rating life" is not less than 50,000 "life hours" continuous operation at maximum speed and pressure for each AMCA fan class. If requested by Engineers, submit bearing selection calculations for approval.

2.05 VIBRATION ISOLATION

A. Fan manufacturer to furnish vibration isolation equipment for each piece of equipment supplied.

2.06 ROOF CURBS

A. Furnish prefabricated welded galvanized steel roof curb for all roof fans. Roof curb with rigid fiberglass insulation and wood nailer held in place by metal wrap-around. Standard height to be 12" above finished roof unless otherwise noted. Roof curbs will be fully assembled and placed onto the roof by the MC for installation by GC.

B. Bottoms of curbs to sit level on roof. Contractor is to verify any roof pitches prior to submittal. Provide pressure treated wood blocking to raise roof curb base to top of finished roof surface.

C. Roof curb to include metal liner to protect insulation (NO EXCEPTIONS!).

D. Cant strips formed into curb body. Provide raised cant for use with insulated roof decks. For fans located on rubber roof membranes raised cant is not to be supplied with curb.

E. For units with dampers furnished by fan manufacturer provide damper shelf mounted inside of curb. Alert duct sub-contractor to this condition for proper damper and duct installation.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install equipment in strict accordance with manufacturer's instructions and so as to be compatible with intent of the respective system performance requirements.

B. Field services shall be provided by a factory trained representative to fully set-up and adjust the new units, after the installations have been completed and before the units are placed in service. Written start-up report to be furnished. Factory alignment, mechanical seals, lubrication, three phase motor rotation, and all necessary commissioning tests shall be completed and checked before units are placed in service.

C. Install vibration isolators in strict accordance with manufacturer's instructions.

D. Provide all necessary supporting ironwork for equipment requiring same.

E. Provide guards for all exposed belts, shafts or fan wheels.

F. Change pulley sizes as many times as necessary, as part of contract, to make systems deliver specified quantities of air.

G. Roof curb must be roofed and flashed to the top of wooden nailer to assure weather tightness.

H. Bolt fan housing to curb.

END OF SECTION

SECTION 233710 - LOUVERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including the General and Supplementary Conditions and Division 1 Specification Sections apply to the work of this section.

1.02 SUBMITTALS

A. Submit product cut sheets, indicating performance data, sizes, accessories, etc.

B. Submit color chart for Architect's approval

PART 2 - PRODUCTS

2.01 LOUVERS

A. LO-1: Greenheck Model #ESJ-202; or equal, stationary formed aluminum louver, size as shown on drawings. In general, louver to be non-flanged for brick and flanged for metal storefront or metal siding – contractor review drawings and in field prior to ordering louver. 2" deep, blade with rain hook and lip at front and rear edges, 3" spacing at 37 degrees. Blades and frames of extruded aluminum construction with integral caulking recess. Blades shall be #6063-T5 aluminum. Louver to have AAMA 2605 compliant coatings (70% Kynar PVDF/100% Fluoropolymer FEVE). Contractor shall furnish color selection as per Architect's instructions. Provide polyvinyl chloride coated wire bird screen 1/2" sq. mesh mounted on inside face.

B. LO-2: Greenheck Model #ESK-402; or equal, stationary drainable extruded aluminum louver, size as shown on drawings. In general, louver to be non-flanged for brick and flanged for metal storefront or metal siding – contractor review drawings and in field prior to ordering louver. 4" deep, drainable blade lip at front and rear edges, 4" spacing at 45 degrees. Blades and frame of .081" extruded aluminum construction with integral caulking recess. Blades shall be #6063-T5 aluminum. Louver to have AAMA 2605 compliant coatings (70% Kynar PVDF/100% Fluoropolymer FEVE. Contractor shall furnish color selection as per architects' instructions. Provide polyvinyl chloride coated wire bird screen 1/2" sq. mesh mounted on inside face.

PART 3 - EXECUTION

3.01 GENERAL

A. Contractor to install louver in existing masonry opening and caulk between louver and wall and secure to wall.

B. Contractor to field verify exact masonry opening size prior to ordering louver.

C. GC to provide opening.

D. Install in accordance with manufacturer's instructions.

END OF SECTION

SECTION 233713 - DIFFUSERS, REGISTERS AND GRILLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this section.

1.02 SUBMITTALS

A. Schedule indicating drawing no., room location, quantity, size, throw, direction of throw, accessories, finish, material type, color chart, etc.

B. Product data sheet for each unit indicating throw, noise criteria ratings, directional data (four-way, etc.) material, accessories, mounting details, etc.

C. Noise criteria shall conform with specified equipment performance data.

D. If requested by Engineer, provide sample of diffuser, register, grille, etc.

1.03 GENERAL REQUIREMENTS

A. Duct drawings are diagrammatic and do not provide exact locations for diffusers, registers and grilles. Contractor shall reference reflected ceiling plans or instructions by Architect for a more exact location of diffusers, etc., with respect to ceiling grid, light fixture and sprinkler etc.

B. Each manufacturer shall check noise level ratings for their equipment to insure that the sizes selected will not produce noise to exceed 30 db, "A" scale, measured at occupant level; notify Engineer of any problems in this regard and change equipment size accordingly.

1.04 REQUIREMENTS FOR DIFFUSERS, REGISTERS AND GRILLES

A. All units and accessories shall be installed "sight-proof" where possible.

B. Borders and frames shall be of same material and color as specified for grille face.

C. Total quantity of air equally divided, or as required and/or shown, where diffusers blow in more than one direction. Provide blank off plate (finished to match unit) to match blow pattern shown on drawings.

D. Each supply register and diffuser shall be guaranteed to deliver indicated capacity and proper throw with draftless diffusion, and within acceptable noise level.

E. Limit terminal velocity at walls of room, below 25 fpm, measured 4' above floor.

F. Contractor shall provide proper duct connection to all diffusers, registers and grilles. Ductwork connections shall be as required by unit manufacturer. Connections required by Contractor include but are not limited to square/round adapter, transitions, flanges, neck rings, etc.

G. Because of intricate system designs and special performances required, all devices may not be of same make.

H. Suitable for recessed mounted unless otherwise indicated.

I. Diffusers and registers that are scheduled with integral opposed blade volume damper at neck must match unit construction and must be able to be adjusted through face, without removing unit.

J. Diffusers, registers and grilles do not require volume control dampers unless specifically indicated.

K. All exposed fasteners must be tamper proof.

L. Security Grille Face: Where indicated, provide heavy duty security type, tamper proof, secure grille face. Grille shall be 12 ga. thick cold rolled steel 1/2" sq. perforated grille. Fasteners shall be located 6" C/C around perimeter. Unit shall have white prime finish suitable for field painting. Provide A.J. Manufacturing Co.; or equal.

PART 2 - PRODUCTS

2.01 GENERAL

A. See drawings for schedule.

2.02 TRANSFER GRILLE ASSEMBLY

A. TG-1: Furnish and install where indicated on drawings, TG-1 assembly consisting of: (2) grilles, (1) fire damper and (1) duct sleeve. Each grille shall include plaster frame. Fire damper shall be 1-1/2hr, Air Balance Model #119AF; or equal. Locate as shown. Paint all visible interior surfaces flat black. Do not paint fire damper.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All equipment specified under this section shall be installed where called for on plans and in compliance with the contract documents.

B. Install equipment in strict accordance with manufacturer's instructions and so as to be compatible with intent of the respective system performance requirements.

C. Diffusers in lay-in type ceiling tiles shall be located at center of tile, squared with tile edges.

END OF SECTION

SECTION 237313 – ENERGY RECOVERY UNITS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this section.

1.02 SUBMITTALS

A. Schedule of units and accessories.

B. Unit capacities, ratings, weights, etc.

C. Dimensional shop drawings for units and accessories.

D. Sound power data.

E. Motor ratings. Motor efficiency shall comply to EISA standards.

F. Operation and maintenance manuals.

G. If unit is a substitution, provide 3/8"=1'-0" scale drawing with submittal indicating unit, coil removal, service area and surrounding ductwork and piping to prove substitute unit fits into intended space.

1.03 GENERAL REQUIREMENTS

A. Central station equipment and accessories shall be factory tested and certified by Air Conditioning and Refrigerant Institute (ARI). Units ratings shall comply with ARI 430 standards.

B. Units shall be factory assembled complete, and be ready to operate with all required and listed components necessary for proper operation.

C. Provide fan and motor drive assemblies with required accessories.

D. Units shall include internal vibration isolation. For units specified without internal vibration isolation, contractor shall furnish and install external isolators and related hardware.

PART 2 - PRODUCTS

2.01 Fixed Plate Energy Exchanger Units:

A. Product Specification:
Energy recovery ventilator (ERV) shall be a packaged unit and shall transfer both heat and humidity using static plate core technology.

Unit shall be Listed under UL 1812 Standard for Ducted Air to Air Heat Exchangers. Some exceptions to UL Listing may apply.

The ERV core shall be warranted to be free of manufacturing defects and to retain its functional characteristics, under circumstances of normal use, for a period of ten years from the date of purchase. The balance-of-unit shall be warranted to be free of manufacturing defects and to retain its functional characteristics, under circumstances of normal use, for a period of (1) year from the time of acceptance by owner.

B. Performance:

1. Energy Transfer: The ERV shall be capable of transferring both sensible and latent energy between airstreams. Latent energy transfer shall be accomplished by direct water vapor transfer from one airstream to the other, without exposing transfer media in succeeding cycles directly to the exhaust air and then to the fresh air.

2. Passive Frost Control: The ERV core shall perform without condensing or frosting under normal operating conditions (defined as outside temperatures above -10°F and inside relative humidity below 40%). Occasional more extreme conditions shall not affect the usual function, performance or durability of the core. No condensate drains will be required.

3. Continuous Ventilation: Unit shall have the capacity to operate continuously without the need for bypass, recirculation, pre-heaters or defrost cycles under normal operating conditions.

4. Positive Airstream Separation: Water vapor transfer shall be through molecular transport by hydroscopic resin and shall not be accomplished by "porous plate" mechanisms. Exhaust and fresh airstreams shall travel at all times in separate passages, and airstreams shall not mix.

5. Laminar Flow: Airflow through the ERV core shall be laminar over the products entire operating airflow range, avoiding deposition of particulates on the interior of the energy exchange plate material.

C. Construction:

1. The energy recovery component shall be of fixed-plate cross-flow construction, with no moving parts.

2. No condensate drain pans or drains shall be allowed and unit shall be capable of operating in both winter and summer conditions without generating condensate.

3. The unit case shall be constructed of G90 galvanized, 20-gauge steel, with lapped corners and zinc plated screw fasteners.

4. Access doors shall provide easy access to blowers, ERV cores, and filters. Doors shall have an airtight compression seal using closed cell foam gaskets. Pressure taps, with captive plugs, shall be provided allowing cross-core pressure measurement allowing for accurate airflow measurement.

5. Case walls and doors shall be insulated with 1", 4 lb. density, foil/scrim faced, high-density fiberglass board insulation, providing a cleanable surface and eliminating the possibility of exposing the fresh air to glass fibers, and with minimum R-value of 4.3 (hr·ft2·°F/BTU).

6. The ERV cores shall be protected by a MERV-8 rated, 2" nominal, pleated, disposable filter in both airstreams.

7. Unit shall have single-point power connection and a single-point 24 VAC contactor control connection.

8. Blower motors shall be Premium Efficiency, EISA compliant for energy efficiency. The blower motors shall be totally enclosed (TEFC) and be shall be supplied with factory installed motor starters. Direct drive models shall

be EISA-compliant for energy efficiency with open drip proof design and integral thermal protection.

9. Blowers shall be quiet running, forward curve type and be either direct drive (EV450 and HE1X only) or belt drive. HE6X and HE8X units use backward incline, belt drive blower packages. Belt drive motors shall be provided with adjustable pulleys and motor mounts allowing for blower speed adjustment, proper motor shaft orientation and proper belt tensioning.

10. The unit electrical box shall include a factory installed, non-fused disconnect switch and a 24 VAC, Class II transformer/relay package.

11. The ERV shall be provided "inverter-ready" allowing for applications of inverters supplied and installed by others.

D. Options:

1. Provide double wall construction with 24-gauge galvanized steel liner.
2. Provide factory installed disconnect fuses.
3. Provide factory installed filter monitors for each airstream.
4. Provide MERV-13 filters for final installation after construction phase.

E. Vibration Isolation:

1. Provide rubber or spring type isolators appropriately sized for corner weights of the specific unit.

2. Provide flexible duct connections at unit duct flanges.

F. Controls: Controls by Temperature Control Contractor. See Specification Section 230994 for details.

2.02 MOTORS

A. All motors shall be general purpose squirrel-cage induction type, NEMA Design 8, Class 8 insulation, continuous duty, 40°C ambient, single or multiple speed as scheduled.

B. All three phase motors shall be NEMA Premium Efficiency design. Motor efficiency shall be indicated on the motor nameplate by the manufacturer per IEEE Standard 112 Method 8 in accordance with following tables:

Open Drip Proof (ODP)

Horsepower	1200 RPM	1800 RPM	3600RPM
1	82.5%	85.5%	77.0%
1.5	86.5%	86.5%	84.0%
2	87.5%	86.5%	85.5%
3	88.5%	89.5%	85.5%
5	89.5%	89.5%	86.5%
7.5	90.2%	91.0%	88.5%
10	91.7%	91.7%	89.5%
15	91.7%	93.0%	90.2%
20	92.4%	93.0%	91.0%
25	93.0%	93.6%	91.7%
30	93.6%	94.1%	91.7%

Totally Enclosed Fan-Cooled (TEFC)

Horsepower	1200 RPM	1800 RPM	3600 RPM
1	82.5%	85.5%	77.0%
1.5	87.5%	86.5%	84.0%
2	88.5%	86.5%	85.5%
3	89.5%	89.5%	85.5%
5	89.5%	89.5%	86.5%
7.5	91.0%	91.7%	98.5%
10	91.0%	91.7%	90.2%
15	91.7%	92.4%	91.0%
20	91.7%	93.0%	91.0%
25	93.0%	93.6%	91.7%
30	93.0%	93.6%	91.7%

C. Single speed motors shall operate at 1750 RPM unless otherwise indicated.

D. Motors controlled by Variable Frequency Drive (VFD) units shall be rated for inverter duty (NEMA MG1, Part 31).

PART 3 - EXECUTION

3.01 GENERAL

A. Install all equipment in strict accordance with manufacturer's instructions.

B. Field services shall be provided by a factory trained representative to fully set-up and adjust the new units, after the installations have been completed and before the units are placed in service. Written start-up report to be furnished. Factory alignment, mechanical seals, lubrication, three phase motor rotation, and all necessary commissioning tests shall be completed and checked before units are placed in service.

C. Provide one (1) complete spare set of filters for each unit. After building is complete and is fully occupied contractor shall remove and dispose of construction filter set and install new set.

D. Provide flexible duct collars to SA, RA and OA connections.

E. On units without internal vibration isolation, provide external spring isolators.

F. Provide all secondary steel necessary to mount units.

G. Lubricate bearings, pulleys, and other moving parts, with factory recommended lubricants.

H. Contractor is responsible for coordinating piping and motor locations (i.e. - L.H. or R.H.) to match drawings and/or actual job site conditions.

END OF SECTION

SECTION 237450 - ROOF EQUIPMENT SUPPORTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General provisions of the Contract including the General and Supplementary Conditions and Division 1 Specifications Sections, apply to the work of this section.

1.02 SUBMITTALS

A. Dimensioned Schedule of all equipment
B. Shop drawings on all equipment and accessories specified hereinafter.
C. Product data cut sheets for each item supplied.

1.03 GENERAL REQUIREMENTS

A. Provide roof mounted supports to fit intended use and location as indicated on plans and/or specified.

B. Quantity, size and arrangement, as necessary to obtain required results and allow for proper support.

C. Contractor shall verify actual equipment dimensions and supports and adjust dimensions accordingly for actual equipment supplied.

D. Rails and pedestals are to be used to support exterior equipment ductwork, and/or piping.

E. Rails must be mounted perpendicular to joists, with an 8" overhang on each end.

PART 2 - PRODUCTS

2.01 ROOF EQUIPMENT SUPPORT RAILS (RESR)

A. This contractor shall furnish prefabricated 18 gauge welded galvanized steel rail with integral base plate. Size to be 12” larger than unit that it supports or a minimum of 8" overhang each end over joist (whichever dimension is larger). This contractor shall verify actual length dimensions required. This Contractor shall provide pressure treated top rail/wood blocking and metal cap flashing of sufficient width and length to cover insulation. Insulation, flashing, roof membrane, cap flashing and sealants shall be installed on rail by General Contractor. Rail to be Model ER-2B; RPS Corporation.

B. Rail Slope Roof: Where required, for sloped roof structures, provide uneven rail dimensions to maintain top rail’s level.

C. Rail Installation: This Contractor shall furnish rail units and turn over to GC for installation.

D. Vibration isolation and Pads: To be provided with rails for each piece of equipment.

2.02 ROOF EQUIPMENT SUPPORT RAILS – REFRIGERANT PIPING

A. This contractor shall furnish prefabricated reinforced PVC base that shall accommodate a uni-strut rail to be mounted on top. Each pipe will then be fastened directly to the uni-strut. Provide support rail every 6ft. Unit shall not be flashed into the roof. Rail to be Pedestal Plus with U-Channel strut; RPS Corporation

2.03 ROOF EQUIPMENT FRAME (REF)

A. This contractor shall furnish prefabricated equipment frame which shall consist of (4) rubber bases and interlocking Unistrut rails that can support 500lbs for each roof mounted condensing unit. Unit to be assembled on site. Model number RTSEQ-MDF, Eberl Iron works; or approved equal.

2.04 PIPE PENETRATIONS (PITCH POCKET)

A. Each pipe portal shall include an RPS insulated, prefabricated roof curb, a laminated acrylic coated ABS plastic cover with pre-punched mounting holes and molded sealing ring on the collared opening, and an EPDM compression molded rubber cap. Use N28 cap for up to (2) 3/8" through 1" pipes and for up to (2) 1" through 2" pipes; use N18 cap for up to (4) 3/8" through 1" pipes; use N21 cap for up to (4) 1" through 2" pipes; use N62 cap for (1) 2" through 6" pipe; and use N182 cap for (1) 8" through 12" pipe. Each EPDM rubber cap shall include one stainless steel snaplock swivel clamp per nipple.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Coordinate exact mounting locations with structural drawings.

B. Rails and pedestals are to be provided by this Contractor, installation by the GC, including wood blocking where indicated.

C. Install roof support equipment in strict accordance with manufacturer's instructions and so as to be compatible with intent of the respective system performance requirements.

D. Contractor shall coordinate all roof locations and opening sizes, as required.

E. Unless noted otherwise - roof equipment supports shall be flashed by others; roofing modifications do accept equipment supports shall be preformed by others.

END OF SECTION

SECTION 237510 - VARIABLE REFRIGERANT FLOW SYSTEM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary conditions and Division 1 Specification Sections, apply to work in this section.

1.02 SUBMITTALS

A. Shop drawings shall include certified manufacturer's dimensioned drawings for each chassis size specified including required clearances. Submit rated unit capacities, operating weights and accessories on all equipment in this section.

B. Submit parts list, operating, maintenance and installation instructions including unit support requirements.

C. Submittals shall be marked to identify specified information.

1.03 WORK SPECIFIED ELSEWHERE

A. 232300 - Refrigerant Piping & Specialties
B. 237500 - Packaged Rooftop Units
C. 237505 - Packaged Rooftop Units - Heat Recovery Units
D. 230993 - Temperature Controls
E. 230994 - Temperature Controls Software
F. 230995 - Control Wiring & Tubing

1.04 SPECIAL CONDITIONS

A. All equipment shall be by a single manufacturer. Equipment manufactured by multiple companies and packaged will not be accepted.

B. Supplier of equipment shall have established a service department, staffed by factory trained personnel, located within 180 miles of the project, which has been in continuous operation for the past (5) years.

1.05 GENERAL REQUIREMENTS

A. Furnish all labor, materials, equipment and services necessary for and incidental to the installation of all equipment as shown on the drawings and specified hereinafter. Unit supplier shall locally maintain factory trained technicians capable of servicing supplied units.

B. All equipment furnished shall be rated in accordance with ARI Standard 320 and shall be UL listed and labeled. Scheduled capacities and efficiencies are considered the minimum acceptable.

C. Motor efficiency shall comply with EISA standards.

D. Start up and Commissioning Requirements: The system must be started up and commissioned by a factory trained technician.

E. Quality Assurance:

1. The units shall be listed by Electrical Laboratories (ETL) and bear the ETL label.

2. All wiring shall be in accordance with the National Electric Code (NEC).

3. The system will bear the Energy Star label.

4. The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.

1.05 WARRANTY

A. STANDARD LIMITED WARRANTY

1. This warranty applies to compressor and all parts and is limited in duration to ten (10) years starting from the ‘’installation date’’ which is one of the two dates below:
   a) The installation date is the date that the unit is originally commissioned, but no later than 18 months after the manufacture date noted on the unit’s rating plate.
   b) If the date the unit is originally commissioned cannot be verified, the installation date is three months after the manufacture date.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. DESIGN BASIS:

1. The HVAC equipment basis of design is Daikin North America. All bidders shall furnish the minimum system standards as defined by the base bid model numbers, model families or as otherwise specified herein (see Appendix A HVAC Equipment Alternate General Information). In any event, the contractor shall be responsible for all specified items and intents of this document without further compensation.

2.02 HVAC SYSTEM DESIGN

A. SYSTEM DESCRIPTION:

1. The variable capacity heat pump air conditioning system shall be a Variable Refrigerant Volume Series (heat or cool model) system as specified.
2. The system shall consist of multiple evaporators using PID control, joints and headers, a two-pipe refrigeration distribution system condenser unit.
3. The condenser shall be a direct expansion (DX), air-cooled heat pump, multi-zone air-conditioning system with variable speed inverter driven compressors using R-410A refrigerant.
4. The condensing unit may connect an indoor evaporator capacity up to 200% of the condensing unit capacity. All zones are each capable of operating separately with individual temperature control.
5. The condensing unit shall be interconnected to indoor unit models and shall range in capacity from 5,800 Btu/h to 96,000 Btu/h in accordance with manufacturers engineering data book detailing each available indoor unit.
   a) The indoor units shall be connected to the condensing unit utilizing specified piping joints and headers to ensure correct refrigerant flow and balancing. T style joints are not acceptable for a variable refrigerant system.

6. Operation of the system shall permit either cooling or heating of all of the indoor units simultaneously. Each indoor unit or group of indoor units shall be able to provide set temperature independently via a local remote controller, an Intelligent Manager, an Intelligent Controller or a BMS interface.

B. VRV IV X FEATURES AND BENEFITS

1. Each system shall be able to enlarge from single to dual module or dual to triple module without the need for installed main pipe size changes. The manufacturer shall provide predefined pipe sizes and design rules ensuring reliable system operation and offering design flexibility in phased installation applications.
2. Stable Operation – System shall provide stable inverter operation at varied ambient conditions.
3. Auto Changeover – System shall, below the field selected outdoor ambient temperature provide signal to initiate auxiliary or back up heat.
4. Advanced Zoning - A single system shall provide for up to 64 zones.
5. Independent Control - Each indoor unit shall use a dedicated electronic expansion valve with 2000 positions for independent control.
6. VFD Inverter Control and Variable Refrigerant Temperature - Each condensing unit shall use high efficiency, variable speed all “inverter” compressor(s) coupled with inverter fan motors to optimize part load performance. The system capacity and refrigerant temperatures shall be modulated automatically to set suction and condensing pressures while varying the refrigerant volume for the needs of the cooling or heating loads. The control will be automatic and customizable depending on load and weather conditions.
   a) Indoor shall use PID to control superheat to deliver a comfortable room temperature condition and optimize efficiency.
7. Configurator software - Each system shall be available with configurator software package to allow for remote configuration of operational settings and also for assessment of operational data and error codes.
   a) If this software is not provided by an alternate manufacturer, for each individual outdoor unit the contractor shall do the settings manually and keep detailed records for future maintenance purposes.
8. Independent Control - Each indoor unit shall use a dedicated electronic expansion valve for independent control.
9. Flexible Design –
   a) Systems shall be capable of up to 540ft (165m) [623 ft. (190m) equivalent] of linear piping between the condensing unit and furthest located indoor unit.
   b) Systems shall be capable of up to 3,280ft (1,000m) total “one-way” piping in the piping network.
   c) Systems shall have a vertical (height) separation of up to 295ft between the condensing unit and the indoor units.
   d) Systems shall be capable of up to 295ft (90m) from the first REFNET™ / branch point.
   e) The condensing unit shall have the ability to connect an indoor unit evaporator capacity of up to 200% of the condensing unit nominal capacity.
   f) Systems shall be capable of 98ft (30m) vertical separation between indoor units.
   g) Condensing units shall be supported with a fan motor ESP up to 0.32” WG as standard to allow connection of discharge ductwork and to prevent discharge air short circuiting.

10. Oil Return – Each system shall be furnished with a centrifugal oil separator and active oil recovery cycle.
11. Simple wiring – Systems shall use 16/18 AWG, 2 wire, stranded, non-shielded and non-polarized daisy chain control wiring.
12. Outside Air – Systems shall provide outside air capability.
13. Space saving – Each system shall have a condensing unit module footprint no larger than 48-7/8" x 30-3/16" (1694mm x 1242mm x 767mm).
14. Each condensing unit shall include a multi-functional digital display that can provide system operation status such as operating refrigerant temperatures, pressures, outdoor electronic expansion valve opening and compressor operation time.
15. Each condensing unit shall include a service window that can provide easy access to system field settings and operation status without completely removing the condensing unit panel.
16. Advanced diagnostics – Systems shall include a self-diagnostic, auto-check function to detect a malfunction and display the type and location.
17. Each condensing unit shall incorporate contacts for electrical demand shedding with optional 3 stage demand control with 12 customizable demand settings.
18. Advanced controls – Each system shall have at least one remote controller capable of controlling up to 16 indoor units.
19. Each system shall be capable of integrating with open protocol BACnet and LonWorks building management systems.
20. Low sound levels - Each system shall use indoor and condensing units with quiet operation as low as 27 dB(A).
21. The condensing unit shall have configurable settings for intermittent fan operation to help minimize snow accumulation on fan blades when the system is off.

C. PERFOMANCE: per schedule

1. Performance Conditions:
   a) Cooling: Indoor temperature of 80°FDB (26.7°CDB), 67°FWB (19.5°CWB) and outdoor temperature of 95°FDB (35°CDB).
   b) Heating: Indoor temperature of 70°FDB (21.1°CDB) and outdoor temperature of 47°FDB (8.3°CDB), 43°FWB (6.1°CDB).
   c) Equivalent piping length: 25ft (7.5m)
2. Cooling Operation:
   a) The operating range in cooling will be 23°F DB ~ 122°F DB (-5°CDB ~ 50°CDB).
   b) Cooling mode indoor room temperature range will be 57-77°FWB (13.8 - 25°CWB).
   c) Cooling operation may be extended down to 10°F DB when the system is designed with the following limitations:
      (1) The system must be a single module outdoor unit: RXYQ72/96/120/144/168XA.
      (2) The smallest capacity indoor unit connected to the system must be 12,000 Btu/h.
      (3) The system must run continuously in cooling operation with a minimum of 1.5 tons of indoor units in operation.
3. Heating Operation:
   a) The operating range in heating will be -4°F WB – 60°F WB (-20°CWB – 15.5°CWB).

b) Heating mode indoor room temperature range will be 59°FDB - 80°F DB (15°CDB – 26.7°CDB).

2.03 EQUIPMENT

A. ELECTRICAL:

B. WIRING:

1. The control voltage between the indoor and condensing unit shall be 16VDC non-shielded, stranded 2 conductor cable.
2. The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one condensing unit with one 2-cable wire, thus simplifying the wiring installation.

C. REFRIGERANT PIPING:

1. The system shall be capable of refrigerant piping up to 540ft (165m) actual or 623ft (190m) equivalent from the condensing unit to the furthest indoor unit, a total combined liquid line length of 3,280ft (1,000m) of piping between the condensing and indoor units with 295ft (90m) maximum vertical difference, without any oil traps or additional components.
2. REFNET™ piping joints and headers shall be used to ensure proper refrigerant balance and flow for optimum system capacity and performance.
   a) T style joints shall not be acceptable as this will negatively impact proper refrigerant balance and flow for optimum system capacity and performance.

2.04 OUTDOOR/CONDENSING UNIT

A. GENERAL:

1. The condensing unit is designed specifically for use with VRV series components.
2. The condensing unit shall be factory assembled in the USA and pre-wired with all necessary electronic and refrigerant controls.
3. The refrigeration circuit of the condensing unit shall consist of inverter scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and refrigerant accumulator.
4. Liquid and suction lines must be individually insulated between the condensing and indoor units.
5. The condensing unit can be wired and piped with access from the left, right, rear or bottom.
6. The connection ratio of indoor units to condensing unit shall be permitted up to 200% of nominal capacity.
7. Each condensing system shall be able to support the connection of up to 64 indoor units dependent on the model of the condensing unit.
8. The sound pressure level standard shall be that value as listed in the Daikin engineering manual for the specified models at 3 feet from the front of the unit. The condensing unit shall be capable of operating automatically at further reduced noise during night time or via an external input.

9. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for reprogramming.
10. The condensing unit shall be modular in design and should allow for side-by-side installation with minimum spacing.
11. The following safety devices shall be included on the condensing unit; high pressure sensor and switch, low pressure switch, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
12. To ensure the liquid refrigerant does not flash when supplying to the various indoor units, the circuit shall be provided with a sub-cooling feature.
13. Oil recovery cycle shall be automatic occurring 2 hours after start of operation and then every 8 hours of operation.
14. The condensing unit shall be capable of heating operation at -4°F (-20°C) wet bulb ambient temperature without additional low ambient controls or an auxiliary heat source.

B. UNIT CABINET:

1. The condensing unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed galvanized steel panels coated with a baked enamel finish.

C. FAN:

1. The condensing unit shall consist of one or more propeller type, direct-drive 350 or 750 W fan motors that have multiple speed operation via a DC (digitally commutating) inverter.
2. The condensing unit fan motor shall have multiple speed operation of the DC (digitally commutating) inverter type, and be of high external static pressure and shall be factory set as standard at 0.12 in. WG. A field setting switch to a maximum 0.32 in. WG pressure is available to accommodate field applied duct for indoor mounting of condensing units.
3. The fan shall be a vertical discharge configuration with a nominal airflow maximum range of 5,544 CFM to 22,283 CFM dependent on model specified.
4. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.
5. The fan motor shall be provided with a fan guard to prevent contact with moving parts.

D. SOUND:

1. Night setback control of the fan motor for low noise operation by way of automatically limiting the maximum speed shall be a standard feature. Operation sound level shall be selectable from 3 steps.

E. CONDENSER COIL:

1. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.

2. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.
3. The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tube with N-shape internal grooves mechanically bonded on to aluminum fins to an e-Pass Design.
4. The fins shall be coated with an anti-corrosion hydrophilic blue coating as standard from factory with a salt spray test rating of 1000hr per ASTM test standards.
5. The condensing unit shall be factory equipped with condenser coil guards on all sides.

F. COMPRESSOR:

1. The inverter scroll compressors shall be variable speed (PVM inverter) controlled which is capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit.
   a) In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. With each reading, the compressor capacity (INV frequency) shall be controlled to eliminate deviation from target value.
      (1) Non –inverter-driven compressors, which may cause starting motor current to exceed the nominal motor current (RLA) and require larger wire sizing, shall not be allowed.
2. The inverter driven compressors in the condensing unit shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed scroll “G-type” or “J-type”.
3. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type.
   a) At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.
4. The capacity control range shall be as low as 10% to 100%.
5. The compressor’s motor shall have a cooling system using discharge gas, to avoid sudden changes in temperature resulting in significant stresses on winding and bearings.
6. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
7. Oil separators shall be standard with the equipment together with an intelligent oil management system.
8. The compressor shall be mounted on vibration dampening rubber grommets to minimize the transmission of vibration, eliminating the standard need for external spring isolation.
9. In the event of compressor failure, the remaining compressors shall continue to operate and provide heating or cooling as required at a proportionally reduced capacity. The microprocessor and associated controls shall be manually activated to specifically address this condition for single module and manifolded systems.
10. In the case of multiple condenser modules, conjoined operation hours of the compressors shall be balanced by means of the Duty Cycling Function, ensuring sequential starting of each module at each start/stop cycle, completion of oil return, completion of defrost or every 8 hours. When connected to a central control system sequential start is activated for all system on each DIII network.

2.05 VARIABLE REFRIGERANT VOLUME (VRV / VRV-S) AIR CONDITIONING SPECIFICATION – HEAT RECOVERY/HEAT PUMP INDOOR UNITS

A. QUALITY ASSURANCE:

1. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL), in accordance with ANSI/UL 1995/CAN/CSA-C22.2 No. 236-05 (R2009) – Heating and Cooling Equipment and bear the Listed Mark.

2. All wiring shall be in accordance with the National Electric Code (NEC)/Canadian Electrical Code (CEC).

3. The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.

4. The outdoor unit will be factory charged with R-410A.

2.06 DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled according to the manufacturer's recommendations.

PART 3 - PERFORMANCE

3.01 DESIGN BASIS

A. The HVAC equipment basis of design is Daikin. All bidders shall furnish the minimum system standards as defined by the base bid model numbers, model families or as otherwise specified herein (see Key General Specifications Alternate Supplier Checklist). In any event the contractor shall be responsible for all specified items and intents of this document without further compensation.

PART 4 - PRODUCTS

4.01 2x2 CASSETTE UNIT

A. General: Indoor unit model shall be a ceiling cassette fan coil unit, operable with R-410A refrigerant, equipped with an electronic expansion valve, for installation into the ceiling cavity equipped with a decoration panel grille. It shall be available in capacities from 5,800 Btu/h to 18,000 Btu/h. The decoration panel shall be a four-way air distribution type, with fresh white (Munsell N9.5) or Silver color, impact resistant with a washable decoration panel. The supply air is distributed via motorized louvers which can be horizontally and vertically adjusted from 0° to 90°. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while limiting changes in room temperature when used with Daikin remote controls. The indoor units sound pressure shall range from 25.5 dB(A) to 33 dB(A) at low speed measured at 5 feet below the unit.

B. Performance: Per schedule

C. Indoor Unit:

1. The indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, flare connections, condensate drain pan, condensate drain pump, condensate safety shutoff and alarm, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.

2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
3. Both refrigerant lines shall be fully insulated from the outdoor unit or nearest branch connection into the refrigerant network.
4. The 4-way supply air flow can be field modified to 3-way and 2-way airflow to accommodate various installation configurations including corner installations.
5. Return air shall be through the concentric panel, which includes a resin net mold resistant filter.
6. The indoor units shall be equipped with a condensate pan and condensate pump. The condensate pump provides up to 24-13/16" of lift, measured from the drain outlet, and has a built in safety shutoff and alarm.
7. The indoor units shall be equipped with a return air thermistor.
8. The indoor unit will be powered with 208~230V/1-phase/60Hz.
9. The voltage range will be 253 volts maximum and 187 volts minimum.

D. Unit Cabinet:

1. The cabinet shall be space saving and shall be located into the ceiling.
2. Three auto-swing positions shall be available to choose from via field setting.
3. The airflow of the unit shall have the ability to shut down one or two sides allowing for simpler corner installation.
4. Fresh air intake shall be possible by way of direct duct installation to the side of the indoor unit cabinet.
5. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

E. Decoration Panel:

1. The series shall be compatible with three optional decoration panels:
   a) Decoration panel – white.
2. The decoration panel shall be a four-way air distribution type and constructed of impact resistant polymer.
3. The decoration panel dimensions shall measure 24-7/16" x 24-7/16" and shall fit into a standard 2x2 ceiling grid with no overlap of adjacent tiles.
4. The four air discharge outlet louvers shall be independently motorized and controllable. Each louver shall have a visual indicator to easily identify the louver and simplify the airflow configuration.
5. The louver outlets shall be capable of closure to allow for 3-way and 2-way air distribution.
6. The decoration panel shall be a low profile design, extending 5/16" below the ceiling.
7. The decoration panel shall be compatible with the optional space and presence sensor kit, model BRYQ60A2W.
8. The decoration panel color shall be fresh white (Munsell N9.5).
   a) Decoration panel – silver and white.
9. The decoration panel shall be a four-way air distribution type and constructed of impact resistant polymer.
10. The decoration panel dimensions shall measure 24-7/16" x 24-7/16" and shall fit into a standard 2x2 ceiling grid with no overlap of adjacent tiles.
11. The four air discharge outlet louvers shall be independently motorized and controllable. Each louver shall have a visual indicator to easily identify the louver and simplify the airflow configuration.
12. The louver outlets shall be capable of closure to allow for 3-way and 2-way air distribution.
13. The decoration panel shall be a low profile design, extending 5/16" below the ceiling.

14. The decoration panel shall be compatible with the optional space and presence sensor kit, model BRYQ60A2S.
15. The decoration panel color shall be fresh white (Munsell N9.5) and a specialty Daikin Silver color.
    a) Decoration panel.
16. The cassette body shall be compatible with the legacy 2x2 decoration panel.

F. Optional Space and Presence sensor kit:

1. The space and presence sensor shall be color matched to the decoration panel.
2. The sensor kit shall be capable of sensing occupancy within the space and automatically controlling the indoor unit set point in response to the detection of occupancy.
3. The sensor kit shall be capable of automatically adjusting the direction of individual air discharge outlet louvers in response to the detection of occupants in the vicinity of the unit.
4. The sensor kit shall be capable of automatically adjusting the direction of individual air discharge outlet louvers in response to the sensed floor temperature.

G. Fan:

1. The fan shall be driven by a direct-drive DC motor with statically and dynamically balanced impeller and shall have three user-selectable speeds available: high, medium, and low.
2. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output of 50W.
3. The airflow rate shall be available in high, medium, and low settings.
4. When is connected with either the Navigation Remote Controller or the I-Touch Manager, the Auto fan mode shall be selectable.

H. Filter:

1. The return air shall be filtered by means of a washable long-life filter with mildew proof resin.

I. Coil:

1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
3. The coil shall be a 2-row cross fin copper evaporator coil with 22 FPI design completely factory tested.
4. The refrigerant connections shall be flare connections and the condensate will be 1 -1/32 inch outside diameter PVC.
5. A condensate pan shall be located under the coil.
6. A condensate pump with a 24-13/16” lift, measured from the drain outlet, shall be located below the coil in the condensate pan with a built in safety alarm.
7. A thermistor will be located on the liquid and gas line.

J. Electrical:

1. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.

2. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
3. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.

K. Control:

1. The unit shall have controls provided by manufacturer to perform input functions necessary to operate the system.
2. The unit shall be compatible with a Daikin Intelligent Touch Manager advanced multi-zone controller.

L. Optional Accessories to be provided:

1. VISTA Decoration panel – white
2. Direct fresh air intake kit
3. Wired remote controller

4.02 CONTROL BOX

A. General:

1. The control box shall be used to control the flow of R-410a refrigerant to a non-*VRV* air handling unit connected to a *VRV* condensing unit by means of an appropriate expansion valve kit. Each control shall be paired with no more than one expansion valve kit. The shall control the refrigerant flow similar to a standard *VRV* indoor unit by measuring the return air temperature or room temperature of the space and comparing the measured value to the desired set point value.
2. The unit shall be furnished with 2 thermistors required for control of the expansion valve. These thermistors shall be field-installed in the air handling unit as required.
3. The unit shall be furnished with 1 additional thermistor for measuring the return air temperature or room temperature. This thermistor shall be field-installed in the air handling unit or in the conditioned space as required.
4. The unit shall be furnished with 10 capacity setting adaptors, each corresponding to an appropriate capacity selection.
5. The unit shall be furnished with a conduit mounting plate and sealing gasket.

B. Unit Enclosure:

1. The unit enclosure shall be constructed of a polymer resin suitable for indoor or outdoor installation in accordance with UL1995.
2. The unit enclosure shall be constructed such that when opened for electrical connections, the cover shall remain attached to the main body of the control box

C. Electrical:

1. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
2. Transmission (control) wiring between the EKEQMCBAV3-US and the *VRV* outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
3. The length of transmission (power and control) wiring between the EKEQMCBAV3-US and the EKEXV-US shall be a maximum of 65 feet (20m).

4. All wiring shall be in accordance with National Electric Code (NEC)/Canadian Electrical Code (CEC) and any applicable local or regional codes.

D. Control:

1. The control box shall control the expansion valve
2. The unit shall receive a 16V DC analog input from the thermistor used to control space temperature. This thermistor may be placed in the return air stream or in the conditioned space, as appropriate.
3. The unit shall receive a 16V DC analog input from the included liquid pipe thermistor attached to the field supplied air handling unit. The thermistor shall be field-installed as necessary.
4. The unit shall receive a 16V DC analog input from the included gas pipe thermistor attached to the field supplied air handling unit. The thermistor shall be field-installed as necessary.
5. The unit shall be compatible with the indoor unit controllers.
6. The unit shall be capable of receiving a contact input On/Off signal.
7. The unit shall provide a 16V DC output to the expansion valve. This output shall provide both power and communication/control to the expansion valve.
8. The unit shall provide a voltage-free contact signal output for use with the air handling unit fan operation. Additional fan speed control shall be via the DDC controller or other Building Management System control.
9. The unit shall provide a voltage-free contact signal output indicating compressor on/off operation.
10. The unit shall provide a voltage-free contact error signal output.
11. The unit shall provide a voltage-free contact signal output indicating the *VRV* outdoor unit is in a defrost cycle.
12. The VRT function for the *VRV* outdoor unit shall be automatically disabled upon connection of the control box.
13. The unit shall be capable of wiring to the Daikin *VRV* D-III Net communication using the F1,F2 terminal block.

E. Optional Accessories:

1. The unit shall be compatible with the expansion valve for control, field setting and troubleshooting purposes.
2. The unit shall be compatible with the I-Touch Manager.

4.03 Expansion valve

A. General:

1. Expansion valve kit shall be used to control the flow of R-410a refrigerant to a non-*VRV* air handling unit connected to a *VRV* condensing unit. Each shall be paired with one control box. The expansion valve shall be compatible with R-410a refrigerant, and shall be capable of an expansion valve control resolution of 2000 pulses. It shall be available in nominal capacities from 18,000 Btu/h to 192,000 Btu/h.

4.04 PERFORMANCE PER SCHEDULE

A. Unit Enclosure:

1. The unit enclosure shall be constructed of a heavy gauge sheet metal with a powder coat finish, and shall be suitable for both indoor and outdoor installation.

B. Piping:

1. All piping within the unit shall be copper.
2. The unit shall be furnished with refrigerant filter/driers on both the inlet and outlet piping to the expansion valve.
3. External refrigerant connections to the unit shall be brazed connections.
4. Both refrigerant lines shall be fully insulated from the outdoor unit.

C. Electrical:

1. The unit shall not require a dedicated power connection. Power to the expansion valve shall be provided via 12V DC input connection from the paired control box.
2. The power wiring connection shall be made using the factory included 18 AWG wiring harness. The connection shall be capable of up to 65 ft (20m) of wiring length.

D. Control:

1. The control signal to the shall be received via the factory included 18 AWG wiring harness. The connection shall be capable of up to 65 ft. (20m) of wiring length.

E. Optional Accessories:

1. The control signal to the expansion valve shall be received via the factory included 18 AWG wiring harness. The connection shall be capable of up to 65 ft. (20m) of wiring length.

4.05 NAVIGATION REMOTE CONTROLLER

A. Navigation (NAV) Remote Controller

1. The NAV Remote Controller can provide control for all VRV indoor units. The remote controller wiring consist of a non-polar two-wire connection to the indoor unit at terminals P1/P2. The NAV Remote Controller is wall mounted and can be adjusted to maintain the optimal operation of the connected indoor unit(s). The NAV Remote Controller does not need to be addressed.

2. The NAV Remote Controller can be used in conjunction with the (Simplified Remote Controller) or another NAV Remote Controller to control the same indoor unit group. No more than 2 remote controllers can be placed in the same group.

B. Mounting:

1. The NAV Remote Controller shall be mounted into a standard 2” x 4” junction box.

C. Display Features:

1. The NAV Remote Controller shall be approximately 4.75” x 4.75” in size with a 2.75” x 1.75” LCD display.
2. Backlit LCD display with contrast adjustment and auto off after 30 seconds.
3. Display language shall be English.
4. Selectable display – Detailed, Standard and Simple
   a) Detailed display
      (1) Shall display Operation Mode, Cool, Heat and Setback setpoints, Fan Speed, Louver position, Room Temperature, Time and Day of the Week

b) Standard display
(1) Shall display Operation Mode, Cool, Heat and Setback setpoints and Fan Speed
c) Simple display
(1) Shall display Operation Mode, Cool, Heat and Setback setpoints, Fan Speed and Room Temperature
(2) The room temperature shall be displayed with a large 11/16" font

5. All displayed items configurable
a) Configure "Off" to be displayed when unit is turned off (field setting required)
(1) Prevents mode adjustment
b) Setpoint can be removed from display when unit is turned Off (field setting required)
(1) Prevents setpoint adjustment
c) Fan speed display removable (field setting required)
(1) Prevents fan speed adjustment
6. System Status icons.
7. The controller shall display temperature setpoint in one degree increments with a range of 60-90°F (16-32°C)
8. Detailed and Simple display will reflect room temperature (0-176°F/-18-80°C range in one degree increments).
a) Display of temperature information shall be configurable for Fahrenheit or Celsius
9. On/Off status shall be displayed with an LED.
10. Error codes will be displayed with a two digit code in the event of system abnormality/error.
a) A blinking LED will also signal system abnormality/error
11. The following system temperatures can be displayed to assist service personnel in troubleshooting:
a) Return Air Temperature
b) Liquid Line Temperature
c) Gas Line Temperature
d) Discharge Air Temperature (depending on unit),
e) Remote Controller Sensor Temperature
f) Temperature used for Indoor Unit Control

12. Basic Operation:
a) Capable of controlling a group of up to 16 indoor units.
b) Controller shall control the following group operations:
(1) On/Off, Operation Mode (Cool, Heat, Fan, Dry and Auto* (*with VRV Heat Recovery & Heat Pump Systems))
(2) Configure only the essential modes to be selectable – remove unnecessary mode selection(s) from display
(3) Independent Cooling and Heating setpoints in the occupied mode
(4) Dual setpoints (individual Cool and Heat setpoints with minimum setpoint differential 0 – 7°F (0 – 4°C) default 2°F (1°C)) or Single setpoint
(5) Independent Cooling Setup and Heating Setback setpoints in the unoccupied mode
c) Fan Speed
(1) Up to 5 speeds (dependent on indoor unit type)
(2) Vane direction and oscillation (dependent on indoor unit type)
d) Airflow direction
(1) Up to 5 louver positions and auto swing
e) Individual airflow
(1) Provides individual control of up to four (4) louvers on an indoor unit
f) Dual airflow

13. Provides control of both internal and external louver positions
    a) Automatic draft protection
        (1) Automatically prevents air flow from blowing directly on occupants
    b) The controller shall be able to limit the user adjustable setpoint ranges individually for cooling and heating in the occupied period
    c) Function button lockout (On/Off, Mode, Fan Speed, Up/Down, Left, Right Arrows)
    d) Optional Controller Face Decal to hide unnecessary (locked out) buttons
    e) Indoor Unit group assignment
    f) Filter indicator
    ○ Filter service indicator shall be displayed after 100, 1250 or 2500 (default) hours of run time configurable via field setting
    g) Clock (12/24 hour) and Day display
    h) Automatic adjustment for Daylight Savings Time (DST)
        (1) Set changeover period (second Sunday in March / first Sunday in November)

14. Programmability:

    a) Controller shall support schedule settings with selectable weekly pattern options.
        (1) 7-day
        (2) Weekday + Weekend
        (3) Weekday + Saturday + Sunday
        (4) Everyday
        (5) The schedule shall support unit On/Off
        (6) Independent settings for Cooling and/or Heating setpoints when unit is on (occupied)
        (7) Independent Setup (Cooling) and Setback (Heating) setpoints when unit is off (unoccupied)
        (8) A maximum of 5 operations can be schedulable per day
        (9) Time setting in 1-minute increments
    b) The Controller shall support Auto-changeover mode for both Heat Pump and Heat Recovery systems, therefore, allowing the optimal room temperature to be maintained by automatically switching the indoor unit's mode between Cool and Heat according to the room temperature and temperature setpoint.
        (1) Changeover to cooling mode shall occur at cooling setpoint + 1°F (0.5°C) as the primary changeover deadband and takes the guard timer into consideration
            (a) Configurable from 1 – 4°F (0.5 – 2°C)
        (2) Changeover to cooling mode shall occur at the primary changeover deadband to cooling + 1°F (0.5°C) as the secondary changeover deadband.
            (a) Configurable from 1 – 4°F (0.5 – 2°C)
        (3) Changeover to heating mode shall occur at heating setpoint - 1°F (0.5°C) as the primary changeover deadband and takes the guard timer into consideration
            (a) Configurable from 1 – 4°F (0.5 – 2°C)
        (4) Changeover to heating mode shall occur at the primary changeover deadband to heating - 1°F (0.5°C) as the secondary changeover deadband.
            (a) Configurable from 1 – 4°F (0.5 – 2°C)
        (5) 1 hour guard timer
            (a) Upon changeover, guard timer will prevent another changeover during this period.

(b) Guard timer is ignored by a change of setpoint manually from either the Multi-zone Controller, Remote Controller, or by schedule.

(c) The Guard timer is also ignored if the space temperature reaches the secondary changeover deadband (configurable from 1 - 4°F (0.5 – 2°C)) from the primary changeover deadband, and the guard timer has been activated

(d) 60 minutes as default, configurable to 15, 30, or 90 minutes

c) The controller shall support the Auto-setback by sensor function (dependent on indoor unit type)

(1) The cooling and heating setpoints shall gradually relax (configurable) internally when the room is determined to be unoccupied

(a) The internal setpoint shall return to the original setpoint when room occupancy is detected

d) The controller shall support the Auto-off by sensor function (dependent on indoor unit type)

(1) The indoor unit shall turn off when it is determined that the room is unoccupied after a specified time has elapsed

(a) The indoor unit shall be turned on manually when occupancy is detected

e) The controller shall support the Filter Auto Clean function to be performed once a day (dependent on indoor unit type)

(1) Eight (8) time periods (00:00-03-00, 03:00-06:00, 06:00-09:00, 09:00-12:00, 12:00-15:00, 15:00-18:00, 18:00-21:00, 21:00-00:00) shall be available to select from to enable the automatic filter cleaning function

(a) Default time period (00:00 to 3:00) shall be used if the period for filter auto cleaning is not specified

(2) The indoor unit shall be stopped during auto filter cleaning function operation

f) The Controller shall support an Auto Off Timer for temporarily enabling indoor unit operation during the unoccupied period.

(1) When the Off Timer is enabled and when the unit is manually turned on at the remote controller

(2) The controller shall shut off the unit after a set time period

(3) The time period shall be configurable in the controller menu with a range of 30-180 minutes in 10 minute increments

4.06 BUILDING MANAGEMENT SYSTEM INTEGRATION (OPEN PROTOCOL INTERFACE)

A. Physical characteristics

B. General:

1. The VRV Controls Network shall be capable of supporting remote controllers, schedule timers, system controllers, centralized controllers, an integrated web based interface, graphical user workstation, and system integration to Building Management Systems via BACnet®, Lonworks® and Modbus.

C. The BACnet and Lonworks Interfaces shall be made from stainless steel. Each interface shall have a battery backup and LED lights to display status/error. The Modbus Interface shall be a PCB mounted in the outdoor unit that provides LED lights to display status/error.

4.07 ELECTRICAL CHARACTERISTICS

A. General:

1. The BACnet and Lonworks Interfaces will require 24 VAC to power the unit. The Open Protocol Interface shall supply 16 volts DC to the communication bus on the F1F2 (out-out) terminal of the outdoor unit. The Modbus Interface will require 16 VDC to power the unit from the outdoor unit. The voltage may rise or fall in relation to the transmission packets that are sent and received.

B. Wiring:

1. The Open Protocol Interface communication wiring shall be terminated in a daisy chain design at the outdoor unit, which is then daisy chained to branch selector (Heat Recovery system), then daisy chained to each indoor unit in the system and terminating at the farthest indoor unit. The termination of the wiring shall be non-polar. The remote control wiring shall run from the indoor unit control terminal block to the remote controller connected with that indoor unit.

C. Wiring size:

1. Wiring shall be non-shielded, 2-conductor sheathed vinyl cord or cable and 18 AWG stranded copper wire.

4.08 VRV CONTROLS NETWORK

A. The VRV Controls Network is made up of local remote controllers, multi-zone controllers, advanced multi-zone controllers, and open protocol network devices that transmit information via the communication bus. The VRV Controls Network shall also have the ability to be accessed via a networked PC. The VRV Controls Network supports operation monitoring, scheduling, error e-mail distribution, general user software, tenant billing, maintenance support, and integration with Building Management Systems (BMS) using open protocol via BACnet®, Lonworks® or Modbus interfaces; all of which blend to provide the optimal control strategy for the best HVAC comfort solution.

4.09 OPEN PROTOCOL INTERFACES

A. The Open Protocol Interfaces are designed as a translator between the DIII-Net communications and the protocols used in BACnet, Lonworks and Modbus integration. The Daikin VRV Open Protocol Interfaces are compatible with all VRV, SkyAir, and Daikin RA and FTXS indoor units with the use of the KRP928BB2S RA Adapter. The Open Protocol Interface wiring consists of a stranded non-polar two-wire connection to the outdoor unit. The BACnet and Lonworks Interfaces may be wall-mounted. The Modbus interface shall be mounted in the outdoor or indoor unit. The BACnet and Lonworks interface can be used in conjunction with a Building Management System (BMS) to maintain the optimal operation of up to 64 connected indoor unit groups and 128 indoor units (dependent upon interface option configuration). The Modbus interface can be used in conjunction with a Building Management System (BMS) to maintain the optimal operation of a maximum of 16 connected indoor unit groups and 2 outdoor units. In cases where a system or unit error may occur, the VRV controllers and the BMS central monitoring system will display an error code as specified by Daikin.

4.10 INTERFACE FOR USE IN BACNET

A. DMS502B71: Interface for use in BACnet

1. The Interface for use in BACnet shall provide the ability for a Building Management System (BMS) to control all VRV indoor units with the use of the RA Adapter. It shall be capable of controlling a maximum of 2 DIII-Net systems or 64 indoor unit groups (128 indoor units) connected to a maximum of 10 outdoor units on each DIII-Net system. Each DIII-Net system is independent of each other and each DIII-Net system will terminate on its own DIII-Net port (2 DIII-Net ports standard). The Optional DIII Board can be added to the interface. This option provides 2 additional DIII-Net ports to the interface; a total of 4 DIII-Net ports (maximum of 64 indoor unit groups per DIII-Net port) which can handle a maximum of 256 indoor unit groups (512 indoor units) and 40 outdoor units.

2. The Interface for use in BACnet shall support operations superseding that of the Daikin centralized controller, local remote controller, system configuration, daily/weekly scheduling, monitoring of operation status, and malfunction monitoring.

3. The Interface for use in BACnet uses a standard open protocol based on ANSI/ASHREA Standard 135. The BACnet Interface has been certified by the BACnet Testing Laboratories (BTL). The BACnet Interface is compatible with BACnet IP.

4. The interface wiring shall consist of a non-polar two-wire connection to the terminals F1F2 (out-out) of the outdoor unit. The Interface for use in BACnet is wall mounted and is used as a translator between the BACnet Building Management System (BMS) and the VRV DIII-Net communication bus to maintain the optimal operation of the connected indoor unit(s).

5. The Interface for use in BACnet can be used in conjunction with the Navigation Remote Controller, the Simplified Remote Controller, or the Wireless Remote Controller, Intelligent Touch Controller (ITC) with or without the ITC DIII Plus Adapter and the intelligent Touch Manager (iTM) with or without the iTM Plus Adapter to control the same indoor unit groups. No more than 2 remote controllers can be placed in the same group. The remote controller shall require daisy chain wiring for grouping multiple indoor units (up to 16) together. Manual addressing is required of each indoor unit group associated with the Intelligent Touch Controller, intelligent Touch Manager and the Interfaces for use in BACnet.

6. The Interface for use in BACnet shall be equipped with one RJ-45 Ethernet port to support interconnection with a network PC via the Internet or Local Area Network (LAN). The Ethernet connection shall be capable of transmission on 10Base-T and/or 100Base-TX connection at 100 Mbps.

7. The Interface for use in BACnet shall be capable of being configured as a foreign device. It shall be capable of communicating across BACnet Broadcast Management Devices (BBMD) in different subnet networks.

8. The Interface for use in BACnet shall be capable of supporting Change of Value (COV) notification for all available objects.
9. The Daikin BACnet Setup Tool shall be available so that certified commissioning personnel/facility staff can securely log into each Interface for use in BACnet via a PC to support the configuration and testing of the Interface for use in BACnet.

B. Mounting:

1. The Interface for use in BACnet shall be mounted on the wall or in an enclosure.

C. Display Features:

1. The Interface for use in BACnet shall be approximately 10.81” x 10.34” in size.
2. LED display provides the interface’s operational status and alarm.
3. The Interface for use in BACnet shall be capable of displaying indoor unit objects on the BACnet building management system.
4. The Interface for use in BACnet shall provide the BACnet building management system the capability to command the setpoint temperature in 1^0F (0.1^0C) increments with a range of 60^0F - 90^0F (16^0C - 32^0C).
   a) Display of temperature setpoint information shall be configurable for Fahrenheit or Celsius
5. The Interface for use in BACnet shall provide the BACnet building management system the capability to display the room temperature in 0.1^0F (0.1^0C) increments with a range of -120^0F - 180^0F (-84^0C - 82^0C).
   a) Display of room temperature information shall be configurable for Fahrenheit or Celsius
6. Error codes generated by the indoor units, outdoor units, branch selector boxes, and remote controllers shall be displayed on the BACnet building management system in the event of system abnormality/error with a two digit error code as specified by Daikin.
   a) Communication errors between the Interface for use in BACnet and the BACnet building management system shall be displayed with a red flashing LED on the Interface for use in BACnet

D. Basic Operation:

1. The Interface for use in BACnet will provide up to 28 objects that can be monitored/controlled via the BACnet building management system (see the Interface for use in BACnet Design Guide)
2. Capable of controlling up to 64 indoor unit groups (128 indoor units) per DIII-Net port (2 DIII-Net ports standard).
3. Optional DIII Board can be added to increase DIII-Net ports to a total of 4 DIII-Net ports.
   a) This provides a total of 256 indoor unit groups (512 indoor units) that can be monitored and controlled via the BACnet building management system
4. The Building Management System shall control the following group operations:
   a) On/Off
   b) Operation Mode (Cool, Heat, Fan, Auto, and Dry)
   c) Single setpoint setting for Cooling and Heating in the occupied mode.
   d) Fan status
   e) Fan Speed
      (1) Up to 3 speeds (dependent upon indoor unit type)
5. Vane direction (dependent upon indoor unit type)
      (1) 5 fixed positions or swing position
      (2) Remote controller permit/prohibit of On/Off, Mode, and Setpoint
      (3) Filter sign reset for indoor units
      (4) Disable the Intelligent Touch Controller
      (5) Forced off of indoor units
      (6) Forced Thermo-off of indoor units
      (7) Energy saving offset of indoor unit setpoint
      (8) Compressor status
         (a) hermo-on status
         (b) Heater status
6. Capable of providing battery backup power for up to 3 years in total time for the clock.
   a) Settings stored in non-volatile memory

E. Programmability:

1. The BACnet building management system shall support weekly schedule settings through its programming.

    a) The schedule shall support the indoor unit:
        (1) On/Off
        (2) Each scheduled event shall specify time and target group
        (3) Each scheduled event shall include On/Off, Operation Mode, Occupied Cooling Setpoint, Occupied Heating Setpoint, Setup (Cooling) setback setpoint, Setback (Heating) setback setpoint, Remote Controller On/Off Permit/Prohibit, Remote Controller Mode Permit/Prohibit, Remote Controller Setpoint Permit/Prohibit, and Timed Override Enable
        (4) Setup (Cooling) and Setback (Heating) setpoints when unit is Off (unoccupied) by Group
        (5) An override shall be provided for use enabling indoor unit operation during the unoccupied period by the BACnet building management system programming.
2. The BACnet building management system shall support auto-changeover through its programming.
    a) Auto-change shall provide changeover for both Heat Pump and Heat Recovery systems based upon the group configurations. This will allow for the optimal room temperature to be maintained by automatically switching the indoor unit's mode between Cool and Heat in accordance with the room temperature and setpoint temperature.
    b) Changeover shall change the operation mode of the indoor unit that is set as the Changeover Master. The Changeover Master indoor unit shall then change the operation mode of all indoor unit groups daisy chained on the same DIII-Net communication bus to the same outdoor unit in the Heat Pump system or the same branch selector box in the Heat Recovery system.
    c) Changeover to cooling mode shall occur when the room temperature is great than or equal to the cooling setpoint
        (1) Differential to be determined by BACnet building management system programming
    d) Changeover to heating mode shall occur when room temperature is less than or equal to the heating setpoint.
        (1) Differential to be determined by BACnet building management system programming
    e) Guard timer
        (1) Upon changeover, guard timer will prevent another changeover during this period.
        (2) Guard timer should be ignored by a change of setpoint manually from the BMS, Intelligent Touch Controller, Remote Controller, or by schedule.
        (3) Guard timer to be configured by BACnet building management system programming (30 minute minimum recommended)
3. The Interface for use in BACnet shall support force shutdown of associated indoor unit groups.

PART 5 - EXECUTION

5.01 GENERAL

A. All equipment shall be installed in strict compliance with manufacturer's instructions.

B. Install units level and firmly anchored in indicated locations.

C. Furnish wiring diagrams to Electrical installer for power wiring to units.

D. Start-Up Services:

1. Field services shall be provided by a factory trained representative to fully set-up and adjust the new units, after the installations have been completed and before the units are placed in service. Written start-up report to be furnished.
2. Factory alignment, lubrication, motor rotation, and all necessary commissioning tests shall be completed and checked before units are placed in service.

E. Control System Configuration: Contractor shall obtain the services of a factory trained technician to setup and configure all controls for the project. Configuration shall include setup of program parameters for weekly occupied/unoccupied schedules and all timed events; and shall also include programming all other parameters, i.e. all temperature setpoints.

END OF SECTION

SECTION 238115 - AIR COOLED CONDENSING UNITS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this section.

1.02 SUBMITTALS

A. Submit performance data on all equipment in this section, shop drawings, description of all accessories, installation, operating and maintenance manuals.

B. Submittals shall be marked to identify specified information.

C. Submit wiring diagram indicating all field connections and internal controls and logic.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. The condenser unit and evaporator coil of the air conditioning unit shall be matched per ARI Standards and the entire system shall meet or exceed minimum energy efficiency rating as scheduled below.

B. All condenser units shall be selected based on an entering ambient air temperature of 95°F and an air temperature of 80°Fdb/67°Fwb entering the evaporator coil.

C. Provide condenser unit to fit intended use and location as indicated on plans.

D. Motor efficiency shall comply with EISA standards.

2.02 CONDENSER UNIT

A. Condenser coil shall be of nonferrous construction with aluminum plate fins mechanically bonded to seamless copper tube.

B. Condenser fans shall be direct drive, propeller type for vertical discharge. Fan motors shall include permanently lubricated bearings, thermal protection, resilient mountings. Each fan shall include safety guard.

C. Compressors shall be hermetic type, with external spring isolators, capacity control, automatically reversible oil pump, and crankcase heater.

D. Furnish rubber and shear vibration isolation mounting.

E. Furnish all necessary accessories as specified herein and as shown on drawings, including: isolation valves, thermal expansion valve, nozzles and liquid solenoid valves. Refer to Specification Section 232300 - Refrigeration Piping and Specialties.

F. Provide internal vibration isolation.

G. Casing shall be weatherproof unit suitable for outdoor installation, and shall be galvanized steel, zinc phosphatized and finished with baked enamel. Provide removable access panels at all locations requiring servicing.

H. Factory Controls: Controls shall be factory mounted and wired. Furnish the following:

1. High/low pressure switches
2. Compressor overload protection
3. Time delay to prevent short cycling of compressor
4. Low ambient control
5. Winter start package
6. Motor master control package
7. Relay package including 24 Volt transformer and terminal block ready to accept field installed control wiring.

I. Low ambient cut-out to lock out compressor unit below 50ºF (adjustable). Equipment supplier shall install and wire lock-out controls.

J. Hot Gas Bypass: Manufacturer shall furnish and install a hot gas bypass valve, complete with accessories, for all units. Valve shall have an integral solenoid valve and a pilot assembly with an adjustable range. Hot gas bypass shall be factory installed within the unit. Install hot gas bypass to the suction line. Locate the not gas bypass valve close to the compressor. Install a short (as possible), bypass valve-to-discharge line connection. The hot gas bypass line shall be fully insulated.

K. Low Ambient Controls: Provide accessory kit to allow condenser to operate at low outside air conditions. Unit shall operate as head pressure control by modulating condenser fan speed at low OAT. After fan shutdown refrigerant circuit continues to operate. Controller shall be solid state, with integral transformer and remote temperature sensors. Adjustable cut out speed and hand start mode.

PART 3 - EXECUTION

3.01 GENERAL

A. Locate condenser to allow sufficient space for air flow and servicing space requirements.

B. Install unit in strict accordance with manufacturer's instructions.

C. Field services shall be provided by a factory trained representative to fully set-up and adjust the condensers, after the installations have been completed and before the condensing units are placed in service. Written start-up report to be furnished. Factory alignment, mechanical seals, lubrication, three phase motor rotation, and all necessary commissioning tests shall be completed and checked before condensing units are placed in service.

D. Refer to specification Section 232300 - Refrigeration Piping and Specialties; for refrigerant piping systems.

E. Release and adjust compressor hold down bolts before starting unit.

F. After installation is complete, and just prior to completion of project, Contractor shall clean condenser coils, by an approved method, to remove dirt and debris which may have accumulated during construction.

G. Provide wind baffles as recommended by manufacturer.

END OF SECTION

SECTION 238215 - DUCT MOUNTED COILS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including the General and Supplementary Conditions and Division 1 Specification Sections, apply to the work of this section.

1.02 SUBMITTALS

A. Schedule of all equipment and accessories.
B. Coil operating and performance data.
C. Product data sheets.
D. Dimensional arrangement drawings, including connection details.

PART 2 - PRODUCTS

2.01 HOT WATER COILS

A. All equipment tested for not less than 125 psig minimum hydrostatic pressure, unless otherwise specified. Free from expansion and contraction noises and strains. Rating in accordance with standard test codes adopted jointly by IUGA and ASHRAE. Required capacities are shown in schedule and plans.

B. Casings constructed of heavy gauge steel.

C. The primary surface shall be round seamless 5/8" O.D. copper tube, with a minimum of 0.020in tube wall thickness, staggered in the direction of airflow. Tubes shall be on 1-1/2" or 3" centers. High pressure coils shall have cupro-nickel tubes and headers. The secondary surface shall consist of rippled aluminum plate fins for higher capacity and structural strength. Fins shall be constructed of a minimum of 0.0075in aluminum, and have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Bare copper tube shall not be visible between fins. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates.

D. Casings: Casings shall be constructed of continuous galvanized steel with 3/8" diameter bolt holes for mounting on 6"centers. Coil side plates shall be of reinforced flange type for greater strength and ease of stacking coils in banks (booster coils shall be furnished with flanges for slip-and-drive fasteners or full flanged casings for standard installation.)

E. Coils: Coils shall have the connections located to permit universal mounting of the coil for (right- or left-)hand airflow and have equal pressure drop through all circuits. Coils shall be circuited to provide the maximum mean effective temperature difference for maximum heat transfer rates. All coils over 45" fin length shall be furnished with four fin angles to properly position the coil core.

F. Water Heating Coils: Headers shall be seamless copper tubing. The headers shall have intruded tube holes to provide large brazing surface for maximum strength and inherent flexibility. The complete 5W coils shall be tested with 315 pounds air under water and be suitable for operation at 250 psig and 300°F. High pressure coils shall be suitable for operation up to 400 psig and 400°F. Individual tube test and core tests before installation of headers is not considered satisfactory. Hydronic tests alone shall not be acceptable.

G. Coil air flow velocity not to exceed 550 FPM.

PART 3 - EXECUTION

3.01 GENERAL

A. Provide all secondary steel and hangers required for proper installation and support.

B. Install all coils in strict accordance with manufacturer's instructions.

C. Support coils independent of ductwork and piping; coil shall not carry duct or piping loads.

D. Coil and ductwork (minimum 3'-0" upstream and downstream) shall be externally insulated regardless if it is lined duct or not. See ductwork insulation specification.

E. Provide duct access doors on inlet and discharge side of coil.

END OF SECTION

SECTION 238223 - UNIT VENTILATORS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to the work of this section.

1.02 SUBMITTALS

A. Schedule of all components.
B. Schedule of all accessories.
C. Indicate unit capacities on all equipment.
D. Indicate all field connection locations.
E. Unit Vent Arrangement drawings.
F. Unit accessory arrangement drawings.
G. Provide dimensional plan view drawings for accessory cabinets installations.
H. Wiring diagrams.
I. Submit color charts (unit and louver color selection by Architect).
J. Parts list, Operating & Maintenance manuals.
K. Installation instructions.
L. Written report co-signed by clerk of works confirming final filter set installation.

1.03 QUALITY ASSURANCE

A. Unit ventilators shall be listed by Underwriters Laboratories Inc. (UL) for the United States and Canada.

B. Motors shall conform to the latest applicable requirements of NEMA, IEEE, ANSI and NEC Standards.

C. Unit ventilation rate to be certified and tested per Air Conditioning and Refrigeration Institute (ARI) Standard 840.

D. Unit to be certified and labeled compliant with the seismic design provisions of the 2016 New York State Building Code including independent testing agency requirements.

1.04 GENERAL REQUIREMENTS

A. Unit vent supplier shall have locally available competent mechanics to provide all types of service for all supplied materials and equipment.

B. Service mechanics shall be factory trained and shall be certified, by the manufacturer, to perform all types of service on supplied equipment.

C. As a part of the initial installation, service mechanics shall start up and adjust units for proper operation.

D. All equipment factory supplied with unit (including manufacturer's controls or other Temperature Control components) shall be properly adjusted, on site, by service mechanics.

E. Equipment supplier shall provide service on all supplied equipment for full guarantee period at no cost to the Owner. Installation service shall include all work necessary for repair of defective, improperly installed or improperly adjusted equipment.

F. Motor efficiency shall comply with EISA standards.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Furnish self contained unit ventilator for HVAC service of size, capacity, construction and speed as specified. Units to be fully equipped for intended service as shown on drawings and as specified.

B. Unit ventilator supplier shall locally maintain factory trained technicians capable of servicing supplied units.

2.02 SOUND POWER REQUIREMENTS

A. Schedule:

Unit Max CFM	Unit Size	Unit Speed	Sound Power Data (db re: 10^{-12} watts)						
750	S07	High	57.4	51.8	52.5	52.6	51.2	46.9	35.2
		Medium	50.1	44.9	45.6	44.8	42.8	34.2	19.9
		Low	45.6	40.4	40.8	39.1	35.7	24.4	12.0
1000	S10	High	57.0	52.8	53.9	53.7	51.5	46.8	35.9
		Medium	52.9	48.6	50.2	49.6	46.5	40.1	27.9
		Low	49.4	45.4	47.0	45.5	42.0	33.6	20.7
1250	S13	High	62.4	55.2	55.7	55.3	54.4	49.7	38.5
		Medium	59.3	52.1	52.5	51.7	50.4	44.0	31.8
		Low	55.6	48.6	49.1	47.2	45.6	37.1	24.0
1500	S15	High	63.8	56.6	58.0	58.2	56.4	52.4	41.9
		Medium	58.4	51.3	52.7	52.4	49.5	43.5	30.5
		Low	54.8	47.6	49.4	47.5	44.2	36.2	21.5
Center Frequency			125	250	500	1000	2000	4000	8000
Octave Band			2	3	4	5	6	7	8

B. Sound tests were conducted using a qualified reverberant room per ANSI S1.31 and ANSI S12.32.

C. Sound test data is based on standard cfm at standard air (fixed density of air at 70°F) in accordance with ARI procedures based upon ARI 350.

D. To calculate the Noise Criteria (NC) for a room, use the sound power level for each octave band for the particular unit speed and subtract the actual room effect. The resulting sound pressure number for each octave band can then be graphed on a NC chart to determine the room NC level.

E. If necessary, the unit manufacturer may use a larger unit running at medium or low fan speed to meet the required maximum noise levels. However, provisions must be made to accommodate the larger units at no cost to the Owner.

2.03 UNIT CONSTRUCTION

A. Cabinet and Chassis:

1. Unit frames shall be of unitized, welded construction, with structural elements aligned in an assembly jig prior to welding, to insure proper dimensions, rigidity, and squareness.

2. Internal sheet metal parts shall be constructed of galvanized steel to inhibit corrosion.

3. Exterior cabinet panels shall be fabricated from furniture grade steel of not less than 16 gauge steel with no sharp edges and no unsightly screw heads and shall receive an electro-statically applied powder paint, and be oven baked with environmentally friendly thermosetting urethane powder finish to provide a high quality appearance. Finish color shall be as selected by Architect from manufacturer's standard colors.

4. The interior areas of the unit ventilator shall be insulated for sound attenuation and to provide protection against condensation of moisture on or within the unit. The unit shall be provided with an ultra-quiet sound package consisting of acoustically matched low speed fans to fan housing, sound barrier insulation material (non-fiberglass) adhered to the bottom underside of the unit top panel, sides of the fan section and sound absorbing insulation (non-fiberglass) material applied to the unit front panel.

5. Units shall be constructed so that testing and troubleshooting can be accomplished in the end pockets of operating units, without affecting the normal air flow patterns through the unit.

6. Each unit shall be provided with a non-fused power interrupt switch that disconnects the main power to the unit for servicing or when the unit is to be shut down for an extended period of time. The fan motor and controls shall have the hot line(s) protected by factory installed cartridge type fuse(s).

B. Coils:

1. All coils shall be installed in a draw through position to assure uniform air distribution over the full-face area of the coil, and an even unit discharge temperature.

2. All heating and cooling coils shall be constructed with copper tubes and mechanically bonded aluminum corrugated plate type fins. All coils shall have aluminum individual unshared fin surfaces. An air break shall exist between coils.

3. Water heating coils shall be furnished with a threaded drain plug at the lowest point, and a manual air vent at the high point of the coil. A factory installed low temperature freezestat shall be provided on the leaving edge of the water heating coil in a wave-like configuration to sense multiple locations and shall react to possible freezing conditions. The unit-mounted controls shall incorporate this device.

4. Steam heating exchanger elements shall be double tube (DT) steam distributing, freeze resistant type with same end, (or for floor units, either same end or opposite end connections), as indicated on the plans. A pressure equalizing device (vacuum breaker) shall be factory installed to prevent the retention of condensate in the coil. The installing contractor shall connect the equalizing device to the return line beyond the trap using the tubing provided.

5. Refrigerant coils shall be supplied with factory-installed thermal expansion valves in lieu of capillary tubes to achieve evaporator performance and to protect the compressor from floodback of liquid refrigerant, ventituri type refrigerant distributor and a refrigerant low temperature limit.

C. Fans and Motor:

1. The fan and motor assembly shall be of a low speed design to assure maximum quietness and efficiency.

2. Fans shall be double-inlet, forward-curved, centrifugal type with offset aerodynamic blades. Fans and shaft shall be statically and dynamically balanced as an assembly in the unit before shipment.

3. Fan housings shall be constructed of galvanized steel incorporating logarithmic expansion for quiet operation. Fan and motor assembly shall be of the direct drive type. Belt drive fans shall not be allowed.

4. Supply motors shall be 115 volt, single phase, 60 Hz, NEMA permanent split capacitor (PSC), plug-in type with auto reset internal thermal overload device designed specifically for unit ventilator operation. Motors shall be located out of the conditioned air stream.

5. Units shall have sleeve type motor and fan shaft bearings, and shall not require oiling more than annually. All bearings shall be located out of the airstream. Bearings in the air stream are not acceptable.

6. Motor speed shall be controlled by factory mounted multi-tap transformer for three (3) speeds, HIGH-MEDIUM-LOW-OFF (not accessible from the exterior of the unit). Fan motor and controls shall each have hot leg protected by a factory installed cartridge fuse.

D. Face and Bypass Damper:

1. Each unit shall be provided with a factory-installed face and by-pass damper, constructed of aluminum. The long sealing edges of the damper shall have silicone rubber impregnated clothe seals for long life and positive sealing. Face and bypass dampers without sealing edges to prevent air bypass shall not be acceptable. The damper ends shall have blended mohair seals along the ends glued to the damper end for a positive seal. Plastic clip-on brushes end seals shall not be acceptable as an end seal. The unit design shall incorporate the face and bypass damper to prevent coil surface wiping and be before the fan in a draw-thru configuration. Face and bypass damper positioned in the direct discharge of the room fan is not

acceptable. The face and by-pass damper shall be arranged to have a dead air space to minimize heat pick-up in the by-pass position.

E. Outdoor & Room Dampers:

1. Each unit shall be provided with separate room air and outdoor air dampers.

2. The room air damper shall be fabricated from aluminum, and be counterbalanced against backpressure to close by gusts of wind pressure, thereby preventing outdoor air from blowing directly into the room.

3. The outdoor air damper shall be two piece, double wall construction fabricated from galvanized steel, with ½" thick, 1½ lb. density glassfiber insulation encapsulated between the welded blade halves for rigidity and to inhibit corrosion. The outdoor air damper shall have additional foam insulation on the exterior surface damper blade and on the ends of the outdoor air chamber. A single blade damper, which can be twisted and will leak air, will not be considered.

4. Dampers shall be fitted with blended mohair seals along all sealing edges. Pressure adhesive sponge neoprene or plastic clip-on brush type sealers for damper seals are not acceptable. Rubber type gasket using pressure adhesive for fastening to metal and exposed to the outside air is not acceptable.

5. Dampers shall use the turned-metal principle on long closing ends with no metal-to-metal contact for proper sealing.

6. The damper shaft shall be mechanically fastened to the blade, and shall operate in bearings made of nylon or other material, which does not require lubrication.

F. Filter:

1. Each unit ventilator shall be equipped with a two-piece filter located to provide filtration of the return air/outdoor air mixture. The entire filter surface must be useable for filtration of 100% room air or 100% of outdoor air. The filter shall be easily accessible from the front, and removable in two pieces without removal of the unit return air damper stop. The unit shall ship with a factory installed 1" thick fiberglass, single-use type.

2. Spare filters shall be:
   a) 1" thick fiberglass, single-use type.

G. Refrigeration System:

1. The refrigeration section shall be constructed of galvanized steel and shall include a factory sealed, factory piped assembly consisting of a hermetically sealed compressor, an outdoor section consisting of one condenser coil, multiple condenser fans with one motor, and an indoor evaporator coil with indoor fan section. No condensate drain piping system shall be required as the cooling condensate is to be disposed of by directing it into the outdoor condenser fan scrolls for re-evaporation on the hot condenser coil. The entire refrigeration system shall

ship as an integral completed assembly, which shall be evacuated, charged and run tested prior to shipment.

2. The condenser fan board and fan housings shall be constructed of galvanized steel. Condenser fan wheels shall be double inlet, forward curved centrifugal type. Condenser fan housings shall be constructed of galvanized steel and have pick up slots for slinging indoor condensate upon the condenser coil for evaporation. One long condenser fan wheel without a fan housing is not acceptable. Fan and motor assembly shall be of the direct drive type. Belt drive fans shall not be allowed.

3. The indoor refrigerant cooling heat transfer coil shall include a thermostatic expansion valve with external equalizer and venturi type refrigerant distributor. A low refrigerant temperature sensor shall be factory installed in a u-bend of the refrigerant indoor coil to protect the system during low refrigerant suction conditions.

4. Refrigerant shall be metered by a thermostatic expansion valve in lieu of capillary tubing to achieve evaporator performance and to protect the compressor from floodback of liquid refrigerant.

5. Unit shall have scroll compressors for maximum quietness. Compressors will operate with two stages for efficiency and improved sound. Compressor shall operate at low stage for slow and medium fan speed to improve dehumidification and reduced sound level. Compressor and fan will operate at high speed for sensible enhancement.

6. The unit shall be furnished and wired with compressor thermal/current overload and high-pressure cutout. Gauge ports shall be provided to allow reading of refrigerant pressures at the suction and discharge of the compressor. Compressor shall be equipped with internal pressure relief valve to protect against excessive pressure buildup.

7. The outdoor condenser coils shall be constructed of copper tubes mechanically expanded to raised lanced aluminum plate fins mechanically bonded thereto and shall be positioned above a stainless steel drain pan.

8. Units with three-phase power shall utilize three phase compressors for balanced electrical compressor loads.

9. Acoustic Treatment
   a) The refrigeration system shall come with an Ultra Quiet configuration using the following: The compressor shall be mounted on neoprene compressor isolators for external vibration isolation. The compressor shall be connected by attenuation loops in both the suction and discharge lines to prevent transmission of vibration to other components within the section. In addition the refrigerant piping shall include braided copper tubing in the suction and discharge lines to further reduce the transmission of compressor pulsations. Straight compressor discharge lines without attenuation loops and/or braided copper flex-tubing are not acceptable. Compressor enclosure panels shall be 16-gauge minimum and crossbroken for additional rigidity to dampen vibration. Compressor jackets or compressors without their own

enclosure cabinets shall not be acceptable. The complete interior of the compressor compartment shall be lined with a multi-functional material that serves as a sound barrier, an absorber of sound and also must act as a decoupler to the compressor enclosure. This multi-functional material shall have a mylar coating on the face to act as a sound reflector and to increase the strength of the material. Damping material shall be textured foam type. The exterior of the compressor compartment shall be coated with a high density damping material to eliminate impact noise and vibration. The right end panel, right hand front [panel, 36" (914 mm) of the right hand end of the center front panel and the hinged top access door shall be coated with a high density material to eliminate noise and vibration.

H. Control Components

1. Each unit ventilator shall be furnished with a factory installed and wired, microprocessor based DDC Unit Ventilator Controller (UVC), by the manufacturer of the unit ventilator, which is pre-programmed, factory pre-tested prior to shipment and capable of complete, stand-alone unit control or incorporation into a building-wide network using an optional plug-in communication module. The UVC shall be preprogrammed with the application code required to operate the unit using ASHRAE Cycle II. The unit control system shall include all required temperature sensors, input/output boards, main microprocessor modules, Local User Interface (referred to as LUI) Touch Pad with Digital LED Display, wiring, 24 volt power and direct coupled damper actuators. The UVC shall support up to 6 analog inputs, 12 binary inputs, and 9 binary outputs plus additional I/O points of 4 analog inputs and 8 binary outputs.

2. All units shall be Face & By-pass Damper Control. The Face and Bypass Damper Actuator shall be direct coupled, floating point actuator that is non-spring returned.

3. The Outdoor Air/Return Air Damper Actuator shall be direct coupled, floating point actuator that spring returns the outdoor air damper shut upon a loss of power.

4. The hot water heating coil shall use a factory furnished, field installed, two position End Of Cycle (EOC) control valve to shut off the heating medium at the end of the heating cycle. Upon a power failure, the heating EOC valve shall spring return to the normally open position for flow of water. End of cycle valves without spring return to the normal position upon a power failure shall not be acceptable. The EOC shall be of the 2-way or 3-way configuration as specified in the valve specifications.

5. The steam heating coil shall use a factory furnished, field installed, two position End Of Cycle (EOC) control valve to shut off the heating medium at the end of the heating cycle. Upon a power failure, the heating EOC valve shall spring return to the normally open position for flow of water. End of cycle valves without spring return to the normal position upon a power failure shall not be acceptable. The EOC shall be of the 2-way or 3-way configuration as specified in the valve specifications.

6. A low refrigerant temperature sensor shall be factory installed on a U-bend of the coil to protect the refrigerant system during low refrigerant suction conditions.

7. The LUI shall provide a unit mounted interface which indicates the current unit operating state, room temperature set point, and can be used to adjust the unit ventilator operating parameters (operating mode, fan speed and occupancy mode). The LUI shall have a digit display, 7 keys (1 key hidden for parameter menu access), 9 individual LED indicators and 3-level password protected security feature.

8. The unit controller shall monitor room conditions, and automatically adjust unit operations (fan speed, temperatures, etc.) to maintain pre-programmed temperature setting selection ranges and ventilation requirements. The control sequence shall be on the basis of ASHRAE Cycle II for normal classroom locations, but shall have exhaust fan interlock for override to bring in full outside air for laboratory/science room applications. The fan speeds shall be high constant, medium constant, low constant and auto, which shall vary the air flow in direct relation to the room load. The fan shall not change speeds in less than ten minutes in any one mode. Two constant fan speed operation shall not be acceptable.

9. Each Local User Interface (LUI) Touch Pad shall have a Digital LED Display status/fault indication.

10. Controls shall allow monitoring and adjustment from a portable IBM compatible PC using the applicable software. When using this PC and software, the unit shall be capable of reacting to commands for changes in control sequence and set points.

11. All units shall come equipped with a factory mounted room temperature sensor located in a sampling chamber (front, center panel) where room air is continuously drawn through for fast response to temperature changes in the room. When using a remote wall-mounted temperature sensor the ability shall exist to simply disconnect the unit-mounted temperature sensor using the provided quick disconnect plug.

12. A discharge air temperature sensor shall be factory located on the second fan from the right to constantly sense unit discharge air temperatures. The unit's discharge air temperature sensor shall work in conjunction with the room temperature sensor to provide for stable discharge air temperatures, even in the event of rapid changes in outdoor air quantities.

13. An outdoor air temperature sensor shall be factory located in the outside air prior to the outside air damper to continually sense outdoor air temperature.

14. The unit shall have three (3) multi-pin External Signal Connection Plugs factory provided and pre-wired with short wire whips that are capped for field wiring of:
    a) A Remote Wall Mounted Temperature Sensor.
    b) External Input Signals (by others): unoccupied, remote shutdown, ventilation lockout, dewpoint/humidity, or exhaust interlock signals. (Available inputs may vary by unit model. Not all functions can be used at the same time.)
    c) External Output Options (by others): lights on/off, motorized water valve open/close, fault indication signal, pump restart, exhaust fan on/off or auxiliary heat signal. (Available outputs may vary by unit model. Not all functions can be used at the same time.)

15. An outdoor air humidity sensor shall be factory located in the outside air prior to the outside air damper to continually sense outdoor air humidity for units using outdoor enthalpy or indoor/outdoor enthalpy type economizer.

16. A room humidity sensor shall be factory located in a sampling chamber (front, center panel) where room air is continuously drawn through for fast response to humidity changes in the room using indoor/outdoor enthalpy type economizer using indoor/outdoor enthalpy type economizer.

I. Control Functions

1. The Unit Ventilator Digital Controller (here after referred to as UVC) shall support ASHRAE Cycle II operation.

2. A discharge air temperature sensor shall be installed in all unit ventilators. The ASHRAE II control algorithm shall override room control and modify the heating, ventilating, and cooling functions (as available) to prevent the discharge air temperature from falling below the Ventilation Cooling Low Limit (here after referred to as VCLL) setpoint.

3. Description of Operation
   a) The Unit Ventilator UVC shall use State Machine programming concepts to define and control unit ventilator operation. This shall eliminate the possibility of simultaneous heating and cooling, rapid cycling, etc. and simplify sequence verification during unit commissioning or troubleshooting.
   b) Super States shall group two or more related states into a single control function such as cooling, or heating, etc. States shall be where all the actual work takes place. Thus within each state the UVC shall enable PI loops and other logic sequences required to control unit ventilator operation within that particular state, while other functions and PI-loops not needed during that state may be disabled. Transitions shall be the logic paths used to determine which State should be made active. These shall be the “questions” the UVC will continually consider/determine for which path is followed and which state is active.
   c) The UVC States and Super States shall be used to define the “normal” unit modes, such as Off, Fan Only, Heat, Emergency Heat, Cool, Auto, Night Purge, and Dehumidification. The UVC shall support several “non-normal” unit modes such as Purge, Pressurize, De-pressurize, and Shutdown, which can be forced via a network connection and override typical UVC operation.

4. Modes of Operation
   a) The UVC shall provide several “normal” Modes of unit operation, these shall include Off, Fan Only, Heat, Emergency Heat, Cool, Heat and Cool, Auto, and Night Purge.

5. Off Mode
   a) An Off Mode shall be provided so that the UVC can be forced into a powered off condition. The Off mode shall be a “stop” state for the unit ventilator; it shall not be a power off state. The Local User Interface module (here after referred to as LUI) or a network connection shall be able to force the unit into the Off mode.
   b) Non-normal unit modes (i.e. Purge, Pressurize, and De-pressurize modes) accessed via a network connection shall be able to force the UVC to perform “special” functions during which the UVC shall appear to be in the Off mode.

6. Fan Only Mode
   a) A Fan Only Mode shall be provided so that the UVC can be forced into a Fan Only operation. The LUI or a network connection shall be able to force the unit into the Fan Only Mode.

7. Heat Mode
   a) A Heat Mode shall be provided to force the UVC shall use primary heat (wet heat) as needed to maintain the effective heating setpoint. The LUI or a network connection shall be able to force the unit into the Heat mode.
   b) When the Heat mode super state becomes active, the UVC shall automatically determine which UVC State to make active; Heat, Low Limit, or Cant Heat based upon the transitions for each of those states. The UVC shall remain in this super state until one of the transition out conditions become true.
   c) The Heat State shall be the “normal” state that the UVC will go into when Heat mode is active. When the Heat State becomes active, the UVC shall continually calculate the Discharge Air Temperature Setpoint (here after referred to as DATS) required to maintain the effective heat setpoint (Space Temperature Setpoint). The calculated DATS shall not be allowed to go above Discharge Air High Limit (here after referred to as DAHL). The face and bypass damper shall be positioned to maintain the classroom temperature setpoint. The UVC shall use primary heat (wet heat) as needed to maintain the current DATS. The UVC shall monitor the wet heat coil leaving air temperature thermostat (if provided) in order to prevent coil freezing conditions (see Wet Heat Coil Leaving Air Temperature Thermostat).
   d) A Low Limit Heat State shall be a “non-normal” state that shall become active if during Heat mode the unit reaches 100% heating and is unable to meet the current Discharge Air Temperature Setpoint required to maintain the effective heating setpoint.
   e) The Cant Heat State shall be a “non-normal” state that the UVC can go into when Heat mode is active. Sensor faults, etc. during the Heat mode shall cause the UVC to make the Cant Heat State active. When the Cant Heat State becomes active, no heating or ventilation shall take place. The OA damper shall be closed. The UVC shall monitor the wet heat coil leaving air temperature thermostat, when provided, in order to prevent coil freezing conditions.

8. Cool Mode

a) A Cool mode shall be provided to force the UVC into Cool Only operation. The Cool mode shall use primary cooling (economizer) and secondary cooling (mechanical compressor type) as needed to maintain the effective cooling setpoint. The LUI or a network connection shall be able to compel the unit into the Cool mode. Additionally, the UVC when set to Auto mode shall automatically compel the unit into the Cool mode as needed. The face and bypass damper shall be positioned to the full face position during compressor cooling (mechanical cooling) to maintain the classroom temperature setpoint.

b) When the Cool mode becomes active, the UVC shall automatically determine which UVC state to make active, Econ, Econ Mech, Mech, DA Heat, Low Limit, Cant Cool, or Dehumidify based upon the transitions for each of those states.

c) An Econ State shall be provided as a “normal” state that the UVC can go into when Cool mode is active. The Econ State shall be typically active in the Cool mode when primary cooling (economizer) is available and adequate to meet the cooling requirements. When the Econ State becomes active, the UVC shall use economizer cooling as needed to maintain the effective cooling setpoint. The UVC shall monitor the DAT to ensure it does not fall below Ventilation Cooling Low Limit (here after referred to as VCLL) setpoint. The UVC shall monitor the wet heat coil leaving air temperature thermostat (if provided) in order to prevent coil freezing conditions.

d) An Econ Mech State shall be provided as a “normal” state that the UVC can go into when Cool mode is active. The Econ Mech state shall typically be active in the Cool mode when primary cooling (economizer) alone is not adequate to meet the cooling requirements and both primary cooling and secondary cooling are available. When the Econ Mech State becomes active, the OA damper shall be set to 100% open, and the UVC shall use the units mechanical cooling capabilities as needed to maintain the effective cooling setpoint. The UVC shall monitor the DAT to ensure it does not fall below the Mechanical Cooling Low Limit (here after referred to as MCLL) setpoint. The UVC shall monitor the wet heat coil leaving air temperature thermostat (if provided) in order to prevent coil freezing conditions.

e) A Mech State shall be provided as a “normal” state that the UVC can go into when Cool mode is active. The Mech State shall be typically active in the Cool mode when primary cooling (economizer) is not available and secondary cooling is available. When the Mech State becomes active, the UVC shall use the units mechanical cooling capabilities as needed to maintain the effective cooling setpoint. The UVC shall monitor the DAT to ensure it does not fall below the Mechanical Cooling Low Limit (here after referred to as MCLL) setpoint. The UVC shall monitor the wet heat coil leaving air temperature thermostat (if provided) in order to prevent coil freezing conditions. The UVC shall be configured to operate the compressor as secondary (mechanical) cooling when the economizer is available, when the economizer is not available and the compressor is available then the UVC shall use the compressor when cooling is required. A compressor envelope shall be established using a sensor on the indoor and outdoor coils to monitor refrigeration temperature conditions. This envelope shall protect the compressor from adverse operating conditions,

which can damage or shorten compressor life by ending compressor operation if coil temperatures exceed the defined operating envelope.

f) A Mech State shall be provided as a “normal” state that the UVC can go into when Cool mode is active. The Mech State shall be typically active in the Cool mode when primary cooling (economizer) is not available and secondary cooling (compressor) is available. When the Mech State becomes active, the UVC shall use the unit's mechanical cooling capabilities as needed to maintain the effective cooling setpoint. The UVC shall be configured to operate the compressor as secondary (mechanical) cooling when the economizer is available, when the economizer is not available and the compressor is available then the UVC shall use the compressor when cooling is required. A compressor envelope shall be established using a sensor on the indoor and outdoor coils to monitor refrigeration temperature conditions. This envelope shall protect the compressor from adverse operating conditions, which can damage or shorten compressor life by ending compressor operation if coil temperatures exceed the defined operating envelope.

g) A DA Heat State shall be provided as a “normal” state that the UVC can go into when Cool mode is active. The DA Heat State shall be typically active when reheat is required to maintain VCLL while maintaining the required OA damper position. When DA Heat State is active, then the UVC shall use the units heating capability as needed to maintain the VCLL setpoint. The Heat Timer (3-minutes fixed) shall begin counting. The UVC shall monitor the wet heat coil leaving air temperature thermostat in order to prevent coil freezing conditions. The UVC shall remain in this state until one of the transition out conditions become true, or until one of the super state transition out conditions becomes true.

h) A Low Limit State shall be provided as a “non-normal” state that the UVC can go into while Cool mode is active. The Low Limit state shall typically follows the DA Heat state when the UVC has reached 100% heat and still cannot maintain VCLL. When the Low Limit State becomes active, the Low Limit PI-loop shall override the OAD minimum position and adjust the OAD toward closed as necessary to maintain the DAT setpoint.

9. Auto Mode

a) An Auto mode shall be provided so that the UVC can be set to automatically determine if heating, cooling or dehumidification is required. The Auto mode shall be the default start-up UVC mode. Auto mode shall be made up of the Heat, Cool and Dehumidify modes. With the UVC set to auto mode, the UVC shall determine which mode (Heat, Cool and Dehumidify) to use.

10. Emergency Heat Mode

a) An Emergency Heat mode shall be provided for situations where the UVC is in a mode that does not normally allow heating, such as Off, Cool, Fan Only, Night Purge, etc. If Emergency Heat mode is enabled and the space temperature falls below the EHS, the UVC shall automatically force itself into the Emergency Heat mode from Off, Cool, Night Purge, Fan Only, Purge, Pressurize, De-pressurize, and Shutdown. Additionally, the LUI or a network connection shall be used to force the unit into the Emergency Heat

mode. Emergency Heat mode shall consists of two UVC states: Full Heat and Cant Heat.

b) A Full Heat State shall be provided as the “normal” state that the UVC will go into when Emergency Heat mode is active. When Emergency Heat (EHS) mode becomes active, the UVC shall go into 100% heating until the space temperature raises to the EHS plus a fixed differential (9°F / 5°C). In the Emergency Heat mode the space fan shall be set to high speed, and the OA damper will operate normally.

c) The Cant Heat State shall be a “non-normal” state that the UVC can go into when Emergency Heat mode is active. Sensor faults, etc. during the Heat mode shall cause the UVC to make the Cant Heat State active. When the Cant Heat State becomes active, no heating or ventilation shall take place. The OA damper shall be closed. The UVC shall monitor the wet heat coil leaving air temperature thermostat (if provided) in order to prevent coil freezing conditions.

11. Night Purge Mode

a) A Night Purge mode shall be provided to quickly ventilate a space. Night purge shall be used to remove odor build up at the end of each day, or after cleaning, painting, or other odor generating operations occur within the space. Night Purge shall be full ventilation with exhaust mode, during which room comfort will be compromised. The LUI or a network connection shall be able to force the unit into the Night Purge mode.

b) When Night Purge mode becomes active, the UVC shall stop all normal heating and cooling as any new energy used to treat the incoming air would be wasted in the purging process. In the Night Purge mode the unit classroom air fan shall be set to high speed, the OA damper will be set to 100% open, and the Exhaust Fan binary output shall be set to On. If not set to another mode within 1-hour, the UVC shall force itself into the Fan Only mode. If the space temperature drops below the EHS, and the Emergency Heat function is enabled, the UVC shall be forced into the Emergency Heat mode. The UVC shall continue to monitor the wet heat coil leaving air temperature thermostat (if provided) in order to prevent coil freezing conditions.

12. Non-Normal Unit Modes

a) Additional UVC modes shall be provided that are considered non-normal unit modes. These shall include Pressurize, Depressurize, Purge, Shutdown and Energy Hold Off. These modes shall force the UVC to perform very specific and limited functions and shall be used with caution and only for short periods as needed. These modes shall be accessed only via a network connection.

b) In each of these non-normal UVC modes, if the space temperature drops below EHS, and the Emergency Heat function enables, the UVC shall be forced into the Emergency Heat Super State mode and then return once the Emergency Heat function is satisfied.

c) A Shutdown mode shall be provided that is the equivalent of the Off mode, but shall be an Off mode forced by a network connection. When in Shutdown mode the UVC shall stop all normal heating, cooling, ventilation (OA damper shall be closed), and fan operation. By default emergency heat

shall not be used during the shutdown mode, however, the UVC can be configured (Emergency Heat Shutdown Configuration) to allow emergency heat operation during shutdown mode. The Shutdown mode shall be accessed via a network connection and a binary input to the UVC.

d) The UVC shall support an Energy Hold Off state, which when active forces the UVC to stop all normal heating, cooling and ventilation. This shall typically be used by a network connection to force the UVC to cease heating, cooling and ventilation when conditions exist where heating, cooling and ventilation are not required or desired. Energy Hold Off mode shall be similar to Shutdown mode except that Energy Hold Off always allows Emergency Heat if required. The Energy Hold Off mode shall be only accessed via a network connection.

e) The UVC shall in the Purge mode use the unit Classroom or Indoor Air Fan (here after referred to as IAF), OAD, and exhaust output as needed to purge the space. The UVC shall stop all normal heating and cooling but allow Emergency Heat if required. The purge mode shall be only accessed via a network connection.

f) The UVC shall in the Pressurize mode use the IAF, OAD, and exhaust output as needed to pressurize the space. The UVC shall stop all normal heating and cooling but shall allow Emergency Heat if required. The Pressurize Mode shall be accessed only via a network connection.

g) The UVC shall in the Depressurize mode use the IAF, OAD, and exhaust output as needed to depressurize the space. The UVC shall stop all normal heating and cooling but does allow Emergency Heat if required. The Depressurize Mode shall only be accessed via a network connection.

13. Occupancy Modes

a) The UVC shall be provided with four occupancy modes: Occupied, Standby, Unoccupied, and Bypass. The Occupancy mode shall effect which heating and cooling temperature setpoints shall be used, IAF operation, and OAD operation. The Manual Adjust Occupancy and Networked Occupancy Sensor network variables, along with the Unoccupied and Tenant Override binary inputs, shall be used to determine the Effective Occupancy.

b) The Occupied mode shall be the normal daytime mode of UVC operation. During Occupied mode the UVC shall use the occupied heating and cooling setpoints, the OAD shall operate normally, and by default the IAF shall remain on. A Networked Occupancy Sensor shall be able to interfaced with the Occupancy Sensor Input variable to select occupancy modes. When the Occupancy Sensor Input variable is used, it shall automatically override any hard-wired unoccupied binary input signal.

c) The Unoccupied Occupancy mode shall be the normal nighttime mode of UVC operation. During Unoccupied mode the UVC shall use the Unoccupied heating and cooling setpoints, the OAD shall remain closed, and the IAF shall cycle as needed for heating or cooling. The IAF shall remain off when there is no need for heating or cooling. A Unit-mounted factory-installed electronic 24-hour/7-day Time Clock shall be provided when the unit operates in Stand-alone or no Network is available. This time clock shall be factory wired to the UVC Unoccupied binary input and shall be settable to automatically place the unit into Occupied and Unoccupied modes based upon its user-configured schedule.

d) The Standby mode shall be a non-normal daytime mode of UVC operation. During Standby mode the UVC shall use the standby heating and cooling setpoints, the OAD shall remain closed, and by default the IAF shall remain on.

e) The Bypass mode (also called Tenant Override) shall be the equivalent of a temporary occupied mode. Once the Bypass mode is initiated it shall remain in effect for a set period of time (120-minutes default). During the Bypass mode the UVC shall use the occupied heating and cooling setpoints, the OAD shall operate normally, and by default the IAF shall remain on. A Tenant Override Switch shall be factory installed in all floor-mounted units. This Tenant Override Switch shall be located near the LUI on the unit. The Tenant Override Switch shall provide a momentary contact closure that can be used by room occupants to temporarily force the UVC into the Bypass Occupancy mode from Unoccupied mode. The optional Remote Wall-mounted Sensors shall include a Tenant Override Switch. This Tenant Override Switch shall provide a momentary contact closure that can be used by room occupants to temporarily force the UVC into the Bypass Occupancy mode from Unoccupied mode. The optional Remote Wall-mounted Sensors shall each indicate a UVC status LED. This status LED shall aid in diagnostics by indicating the UVC Occupancy mode and Fault condition.

14. Space Temperature Setpoints

a) The UVC shall use the six occupancy-based temperature setpoints for heating and cooling, Occupancy mode, and the value of the Network variables Space Temp Setpoint Input, Setpoint Offset Input and Setpoint Shift Input as the basis to determine the Effective Setpoint Output. The UVC shall calculate the effective setpoint based upon the unit mode, the occupancy mode, and the values of several network variables. The effective setpoint shall then be used as the temperature setpoint that the UVC will maintain.

15. LUI Setpoint Offset Adjustment

a) The LUI shall be used to make adjustments to the value of the Setpoint Offset Input variable.

16. Indoor Air Fan Operation

a) The UVC shall support a three-speed IAF with Low, Medium, and High speed. The UVC will calculate the effective fan speed and operation based upon the unit mode, the occupancy mode, and the values of several network variables.

b) The UVC shall be provided with a user selectable Auto Fan Mode feature. When in auto fan mode, the UVC shall use the space temperature PI loop to automatically adjust the fan speed as needed to maintain space temperature. This shall ensure that the UVC will maintain the lowest and quietest fan speeds whenever possible. When in Auto Fan Mode, a maximum of 6 fan speed changes per hour shall be allowed (by default), this shall prevent frequent automatic fan speed changes from disturbing room occupants. During occupied, standby and bypass modes the IAF shall, by default, remain On. During unoccupied mode the IAF shall typically remain off and shall cycle with calls for heating and cooling. The UVC shall be

provided with a Fan Cycling Configuration variable that can be used to force the IAF to cycle with calls for heating and cooling during the Occupied, Standby and Bypass Occupancy modes. When the fan is off, the OA damper shall be closed. This feature shall only be used when it is acceptable that normal ventilation is not required. When the IAF is set to cycle, or during the Unoccupied mode, or when the UVC is placed into Off mode, the UVC shall be configured to continue fan operation for a time period (30-seconds default) after heating or cooling is complete.

17. Outdoor Air Damper Operation
    a) The UVC shall be configured for an Outdoor Air Damper operated by a floating-point actuator. The OA damper actuator shall contains a spring to ensure that the OA damper is closed upon lose of power. The OA damper shall be typically open to the current minimum position during the Occupied and Bypass occupancy modes, and closed during the Unoccupied and Standby Occupancy modes.
    b) The UVC shall be configured to maintain three Outdoor Air Damper minimum positions based upon the operation of the IAF. This shall allow the ability for each unit to be job site configured to provide the amount of fresh air required to the space at each of the three IAF speeds.
    c) The Economizer function shall be used by the UVC to determine if the OA is adequate for economizer (primary) cooling. When both the economizer and mechanical cooling are available, the economizer shall be used as primary cooling and the UVC shall add mechanical cooling only if the economizer is not adequate to meet the current cooling load (i.e. the OA damper reaches 100% and cooling is still required). The UVC shall be configured to support the economizer type of (optional) Temperature Comparison with Enthalpy Comparison Economizer for which the UVC shall use four configuration variables for the Temperature Comparison with Enthalpy Comparison Economizer: Economizer OA Temperature Setpoint, Economizer Temperature Differential and Economizer OA Enthalpy Setpoint, and Economizer Enthalpy Differential. The Economizer Temperature Differential shall compare the classroom air temperature to the OA temperature. The Economizer Enthalpy Differential shall compare the classroom air Relative Humidity to the OA Relative Humidity. If the temperature difference is greater than the economizer temperature differential and the Economizer OA temperature is below the temperature setpoint and the OA Relative Humidity difference is below the enthalpy setpoint and the enthalpy difference is greater than the enthalpy differential than the Economizer function shall be energized.

18. Face & Bypass Damper Control
    a) The UVC shall be configured for a Face and Bypass damper operated by a floating-point actuator.
    b) The UVC shall be configured for a 2-position wet heat EOC valve. The 2-position valve actuator shall contain a spring which will ensure that the wet heat valve is driven open upon a lose of power.

19. Actuator Auto-Zero, Overdrive and Sync
    a) The UVC at power-up shall auto-zero actuators OA damper, F&BP damper and Valve before going into normal operation to ensure proper positioning, this may take as long as 150-seconds after power-up.
    b) The UVC shall be configured such that whenever the floating-point actuator is commanded to go to 0% or 100%, the UVC shall overdrive the actuator one full stroke period past the 0% or 100% position to ensure proper positioning.
    c) Additionally, the UVC shall be configured to sync all actuators once every 12-hours of operation.

20. Water Coil Leaving Air Temperature Thermostat (Freezestat)
    a) A normally-closed Low Temperature Thermostat (Freezestat) shall be factory provided to detect low leaving air temperature conditions on the unit indoor air hot water coil. This thermostat shall be mounted on the discharge airside of the units hot water coil. The low temperature thermostat cutout shall be 38°F (3°C) +/-2 and the cut-in shall be 45°F (7°C) +/-2. When the low temperature thermostat detects low leaving air temperatures (contacts open) the following shall occur during Face and Bypass Heating operation: when the freezestat cuts-out the OAD shall close immediately, the heating EOC valve shall fully open immediately, any mechanical cooling shall be de-energized immediately. If heating is required, the Face and Bypass damper shall modulate, as needed, otherwise the Face and Bypass damper shall go to 100% bypass, auxiliary heat may be used as needed. When the Freezestat resets or cuts-in the UVC shall return to normal operation.

21. External Binary Inputs (Inputs vary by model type. Not all functions can be used at the same time)
    a) The UVC shall be provided with three (3) binary inputs that can provide the following functions. These inputs each shall allow a single set of dry-contacts (no voltage source) to be used as a signal to the UVC, multiple units can be connected to a single set of dry-contacts.
    b) External Binary Input 1 shall be able to be configured as an Unoccupied (default) or dewpoint/humidity signal. The Unoccupied Input Signal shall allow a single set of dry-contacts to be used to signal the UVC to go into Unoccupied or Occupied mode. When the contacts close (Unoccupied) the UVC shall go into Unoccupied mode, when the contacts open (Occupied) the UVC shall go into Occupied mode. The (optional) Dewpoint/Humidity Input Signal shall allow a single set of dry-contacts to be used to signal the UVC to go into Active or Passive Dehumidification. When the contacts close (High Humidity) the UVC shall go into Dehumidification, when the contacts open (Low Humidity) the UVC shall stop dehumidification. The device used must incorporate its own differential dewpoint or differential humidity.
    c) External Binary Input 2 shall only be used for remote shutdown. The Remote Shutdown Input Signal shall allow a single set of dry-contacts to be used to signal the UVC to go into Shutdown mode. When the contacts close (Shutdown) the UVC shall go into Shutdown mode, when the contacts open the UVC shall return to Normal operation. See Non-Normal Unit Modes.

d) External Binary Input 3 shall be able to be configured as a Ventilation Lockout (default) or Exhaust Interlock Signal. The Ventilation Lockout Input Signal input shall allow a single set of dry-contacts to be used to signal the UVC to close the OA damper. When the contacts close (Ventilation Lockout Signal) the UVC shall close the OA damper, when the contacts open the UVC shall return to normal OA damper operation. The Exhaust Interlock Input Signal input shall allow a single set of dry-contacts to be used to signal the UVC that an Exhaust Fan within the space has been energized, the UVC shall reposition the OA damper to a user adjustable minimum position (Exhaust Interlock OA Damper Min Position Setpoint). When the contacts close (Exhaust fan on signal) the UVC shall use the value defined by the Exhaust Interlock OA Damper Min Position Setpoint as the minimum OA damper position regardless of IAF speed, when the contacts open the UVC shall return to normal OA damper operation.

e) The UVC shall be provided with three (3) binary outputs that can provide the following functions (outputs vary by model type. Not all functions can be used at the same time). These outputs shall be relay type outputs that shall to be used with signal level voltages (24vac max) only. External Binary Output 1 output shall only be able to be used as a signal for Space Lights. The Lights On/Off Signal relay output shall provide one set of NO dry-contacts that shall be used to signal the operation of the Space Lights. When the UVC is in Occupied, Standby or Bypass Occupancy modes the relay output shall signal the lights on (contacts closed), when the UVC is in Unoccupied occupancy mode the relay output shall signal the lights off (contacts open). External Binary Output 2 shall only be able to be used as a fault signal. A Fault Signal relay output shall provide a NO, NC, and Common connections that can be used to signal a fault condition. When a fault exists, the UVC shall energize this relay output, when the fault or faults are cleared the UVC shall de-energize this relay output. External Binary Output 3 shall only be able to be used to operate an Auxiliary Heat device (default) or signal Exhaust Fan operation. The Auxiliary Heat Signal relay output shall provide one set of NO dry-contacts that can be used to operate an Auxiliary Heat device. The UVC shall be by default configured to operate a NO Auxiliary Heat device (de-energize when heat is required) such as a wet heat valve actuator with a spring setup to open upon power failure. However, the Auxiliary Heat Configuration variable shall be able to be used to set the UVC to use a NC Auxiliary Heat device (energize when heat is required) such as electric heat. The Exhaust Fan On/Off Signal relay output shall provide one set of NO dry-contacts that can be used to signal the operation of an Exhaust Fan. When the OA damper opens more than the Energize Exhaust Fan OA Damper Setpoint then the relay output shall signal the Exhaust Fan on (contacts closed), when the OA damper closes below this setpoint the relay output shall signal the Exhaust Fan off (contacts open).

J. Unit Ventilator Options/Accessories:

1. Wall Sleeve
   a) Unit manufacturer shall provide a galvanized steel, one-piece wall sleeve that is to be set into the wall opening and butted up directly against the intake louver. The Wall Sleeve shall be provided for the following types of unit ventilator installation (CONTRACTOR TO CHOOSE ONE):
      (1) 16 5/8" unit ventilator exposure into the classroom.
      (2) 19 5/8" unit ventilator exposure into the classroom.
      (3) 21 7/8" unit ventilator exposure into the classroom.
      (4) 28" unit ventilator exposure into the classroom.
   b) Where it is not possible to butt the wall sleeve against the wall intake louver, the contractor shall fabricate and install two (2) horizontal sheet metal baffles between louver and wall sleeve to provide an airtight separation between condenser discharge and condenser outside air, and condenser outside air and room outside air. The wall sleeve is to be permanently fastened in place and shall be suitably sealed, caulked, or grouted by the contractor around the entire perimeter to prevent air leakage.
   c) The wall sleeve shall be fitted with an electrical junction box containing a main "on-off" switch. All field-wiring connections shall be made in this wall sleeve junction box.
   d) It shall be the installing contractor's responsibility to make the final load side power wiring connections between the wall sleeve junction box and the unit terminal block.
   e) The wall sleeve with electrical junction box shall be cartonned separately and shipped to the jobsite preceding the unit ventilator.

2. Outdoor Air Intake Louver:
   a) Panel wall or masonry wall intake louver shall be constructed with vertical blade double brake type blades. Provide weep holes along face of bottom frame and diamond pattern expanded aluminum bird screen on the interior side. Louver shall be fabricated of extruded aluminum 6063-T5. The louver shall be divided in half horizontally across the louver to prevent condenser air recirculation. All louvers shall be 28" (711 mm) high by 2.14" (51 mm) thick. The louver length shall be the entire length of the unit outside section. Each intake louver assembly shall be furnished with a matching four sided flange around the perimeter of the opening of same material and finish as louver. The intake assembly and frame shall be: 16 Ga. vertical blade double brake type aluminum blades in a 14 Ga. frame, with:
      (1) manufacturer's oven baked powder paint finish and color for selection by the Architect.
      (2) clear anodized finish.

3. Classroom Matching Accessories
   a) Furnish and install in accordance with manufacturer's printed instructions, matching accessories; shelf cabinets and filler sections, where indicated on the plans. Colors to match the unit ventilator. Cabinet and filler section top shall be finished with textured paint coating to match the unit ventilator top. (Optional) Top of shelving to be made of Formica.
   b) Shelving lengths to be scaled from drawings. Sinks to be stainless steel.

c) All cabinet sections to have adjustable kick plates, and leveling legs and slots for spline attachment to the unit ventilator matching edges.

2.04 ACCESSORY CABINETS

A. General: Where shown on plans furnish all required accessory cabinets and closure panels for a complete proper installation. All accessory cabinets shall be manufactured by unit vent supplier and unless noted otherwise, shall exactly match unit vent dimensions and finish.

B. Provide accessory cabinets with all necessary trim pieces, filler section and end panels to result in a proper finished appearance. Accessory cabinets shall be reinforced steel construction to match unit vents. Furnish various sizes and types of cabinets to completely fill areas designated on plans. Cabinets shall be supplied to exactly fill wall to wall dimensions where required. Cabinets shall have adjustable mountings to allow exact alignment with unit vent; cabinets shall have adjustable kick plates.

C. Cabinets shall be equipped with rear compartment to accommodate piping and/or draft stop. Rear compartment shall be approximately 5-1/4" deep. All cabinets shall have finished back surfaces to fully conceal rear compartment.

D. Bookshelf Units: Shelf cabinets shall be self supporting with 4 adjustable legs. Units shall be capable of 3 book shelves with adjustable spacing heights. Units to be tagged as follows: 3' bookcase (BC-3), 2' bookcase (BC-2), 1' bookcase (BC-1).

E. The preferred widths for shelf cabinets shall be 3'-0". Shelf cabinets 5'-0" wide or greater are not acceptable; units 4'-0" wide will only be allowed by specific Engineers approval.

F. Utility Compartments: Utility sections shall be self supporting. Furnish width as shown or as required. Utility compartment shall include removable front panel with tamper resistant fastener, and shall be suitable for enclosing valves, controls, etc. Units to be tagged as follows: (UC-1) for a 12" utility compartment, UC-24 for a 24" utility compartment.

G. Filler Sections: Provide wall filler or corner filler section as required by space conditions. Filler section shall be nominal 18" wide field assembled unit. Unit to be tagged as follows: (FP-1).

PART 3 - EXECUTION

3.01 GENERAL

A. GC to provide openings and lintel for wall louvers, installation of louver by this contractor.

B. Contractor shall install galvanized sheetmetal wall sleeve for outside air intake opening. Secure OA wall sleeves to wall rough opening.

C. Contractor shall seal any openings water tight around wall sleeve. (Top, bottom and each end.

1. Install all equipment in strict accordance with manufacturer's instructions and so as to be compatible with the intent of the respective system performance requirement.

2. The System Integrator/Controls contractor shall be responsible for the integration of all factory provided unit mounted controls and unit communications as required/specified for unit integration into the Building Automation System and proper unit operation.

3. Install equipment exposed to finished areas after walls and ceiling are finished and painted. Avoid damage. Contractor shall clean each unit and accessory section of construction dust and debris, prior to turning systems over to the owner.

4. Unit Ventilators: Locate as indicated, level and shim units and anchor to structure. Coordinate exact location of wall louvers. Ensure wall sleeve and splitters are installed correctly. Install shelving where indicated. Provide necessary wall trim pieces for continuous wall-to-wall installation.

5. Contractor shall install clean filters in each unit at time of system commissioning, and shall deliver to the owner one complete set of spare filters, and one spare motor of each type used in the project.

6. Installer shall engage the services of manufacturer's factory trained service technician to provide check, test, and start-up of each unit ventilator system.

7. Contractor shall provide one-year warranty for furnishing parts and labor for replacing any part of the unit ventilator or accessory sections, which becomes defective in operation. Unit ventilator manufacturer's representative shall maintain a local stock of replacement parts to support the systems specified herein.

END OF SECTION

SECTION 238230 - TERMINAL RADIATION UNITS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this section.

1.02 SUBMITTALS

A. Submit manufacturer's specifications for terminal units showing dimensions, capacities, ratings, performance characteristics, gauges and finishes of materials, and installation instructions.

B. Schedule of equipment identified by room number with complete equipment description. Identify units with designations used on drawings.

C. Submit assembly type shop drawings showing unit dimensions, construction details, and field connection details.

D. Submit manufacturer's electrical requirements for power supply wiring to terminal units. Submit manufacturer's ladder type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory installed and portions to be field installed.

E. At Engineer's request submit samples of each type of cabinet furnished.

F. Provide color chart for Architect's use.

PART 2 - PRODUCTS

2.01 FINNED TUBE RADIATION

A. General: Provide finned tube radiation of lengths and in locations as indicated, and of capacities, style and having accessories as scheduled.

B. Locate finned tube radiation on outside walls as indicated, and in accordance with manufacturer's installation instructions.

C. Center Elements under windows. Where multiple windows occur over units, divide element into equal segments centered under each window.

D. Install end trim where units butt against walls. Install end caps on units which do not butt walls. Install access panels centered in front of each shutoff valve, balancing cock, steam trap, or temperature control valve.

E. Cabinets: Minimum 20 gauge cold rolled steel full backplate, minimum 16 gauge front. Brace and reinforce front minimum of 4'-0" O.C. without visible fasteners.

F. Elements - For Hot Water: Copper tube and aluminum fins, with tube mechanically expanded into fin collars to eliminate noise and ensure durability and performance at scheduled ratings.

G. Finish: Flat black heat resisting paint for backplate; factory finished baked enamel, standard colors, selected by Architect on fronts and accessories.

H. Accessories: See drawings for arrangements. Provide accessories as shown on drawings, or specification, or as required for complete installation.

1. End panels, inside and outside corners, and enclosure extensions.
2. Access panels in front of all control, balancing and other valves, air vents and traps.
3. Factory mounted dampers, sill extensions, mullion channels and pilaster covers.

PART 3 - EXECUTION

3.01 INSTALLATION (HYDRONIC UNITS)

A. Isolate each unit with valves to permit servicing of control valves, traps, as shown on pertinent diagrams on plans.

B. Contractor responsible for correct end connections and coil arrangements, with respect to installation of control valves, traps, vents, etc.

C. Refer to Architects at once, any correction, discrepancy or suggested change in size or location.

D. Install all equipment in strict accordance with manufacturer's instructions.

E. Where covers require cutting joints shall be made to fit as closely as possible and shall be free from burrs and jagged edges. Unacceptable cuts shall be corrected at Contractor's expense.

F. Each unit shall have a minimum of (1) one union type connection on each end. Valves or traps with such type connections are acceptable as substitutes.

G. Eccentric reducers are required at all points on horizontal piping where pipe sizes change.

H. Provide manual air vent on return of each heating unit on all up-feed hot water installations.

END OF SECTION

DIVISION 26, 27 AND 28
ELECTRICAL SPECIFICATIONS (EC)
INDEX

SECTION 260010 - ELECTRICAL WORK GENERAL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all General Conditions, Supplementary Conditions, Division 1 specification sections as well as Information to Bidders requirements that are included in the project documents, apply to the work of this Contract.

1.02 ALLOWANCES, ALTERNATES AND UNIT PRICES

A. Refer to Division 1 specifications for allowances, alternates and unit prices required as part of this Contract.

1.03 INTENT

A. The intent of the drawings and these specifications is to provide all systems complete and operative. Whether indicated on the drawings and/or included in the specification or not, provide all materials, equipment and labor usually furnished with such systems.

1.04 DEFINITIONS

As Called for	Materials, equipment including the execution specified/shown in the contract documents.
Code Requirements	Minimum requirements.
Concealed	Work installed in pipe and duct shafts, chases or recesses, inside walls, above ceilings, in slabs or below grade.
Design Make	Indicates minimum requirements for equipment.
ERL	Existing to be relocated. (see definition of relocate).
EXR	Existing to remain. Make connections to maintain circuit.
Exposed	Work not identified as concealed.
Acceptance	Owner acceptance of the project from Contractor upon certification by Owner's Representative.
Furnished by Others	Receive delivery at job site or where called for and install.
Inspection	Visual observations by Owner's site Representative.
Install	Mount or set equipment, device or fixture and make electric connections.
Labeled	Refers to classification by a standards agency.
Make	Refer to the article, BASIS OF DESIGN.
Provide	Furnish and install complete.

Relocate	Disassemble, disconnect, and transport equipment to new locations, then clean, test, and install ready for use.
Replace	Remove and provide new item.
Review	A general contractual conformance check of specified products.
Roughing	Pipe, duct, conduit, equipment layout and installation.
Satisfactory	As specified in contract documents.
Site Representative	Construction Manager or Owner's Inspector at the work site.

Refer to General Conditions of the Contract for additional definitions.

1.05 SCOPE OF WORK

A. In general, the scope of work includes, but is not necessarily limited to the following:

1. Power Distribution: Panelboards, Feeders and Conduits.
2. Grounding of all services, raceway systems, disconnects and devices, etc.
3. Interior lighting, wiring, conduits and switching.
4. Power and convenience outlet branch circuits, devices, etc.
5. Exit and emergency lighting.
6. Power circuits to mechanical equipment.
7. Communications cable and equipment.
8. Wireless Master Clock System.
9. Fire Alarm work.
10. Public Address work.
11. Communications raceways.
12. Removal work.

1.06 BASIS OF DESIGN

A. The contract documents are prepared on basis of one manufacturer as "design equipment," even though other manufacturers' names are listed as acceptable makes. If Contractor elects to use one of the listed makes other than "design equipment," submit detailed drawings, indicating proposed installation of equipment. Show maintenance clearances, service removal space required, and other pertinent revisions to the design arrangement. Make required changes in the work of other trades, at no increase in any contract. Provide larger electrical feeders, circuit breakers, equipment, additional control devices and other miscellaneous equipment required for proper operation and assume responsibility for proper location of roughing and connections by other trades. Remove and replace door frames, access doors, walls ceilings or floors required to install other than design make equipment. If revised arrangement submittal is rejected, revise and resubmit specified "design equipment" item which conforms to contract documents.

1.07 QUALITY ASSURANCE

A. Manufactures of equipment shall be firms regularly engaged in the production of factory fabricated systems and equipment whose products have been in satisfactory use in similar service for not less than (3) years.

B. Suppliers of equipment must have factory trained and authorized personnel for the service of all equipment provided

1.08 LICENSING

A. Where required the contractor shall hold a license, issued or recognized by the authority having Jurisdiction, to perform electrical work.

1.09 INSPECTIONS

A. Provide rough in and final inspection by an electrical inspector certified by the AIAEI (the American International Association of Electrical Inspectors).

1.10 REMOVAL, DISPOSAL AND HAZARDOUS MATERIALS

A. All removed electrical equipment shall be removed from the site and properly disposed of.

B. All hazardous materials must be disposed of in compliance with ENCON and all other regulatory agencies.

C. The Owner may wish to keep certain equipment, therefore, check with Owner before removals to determine what may be salvageable.

1.11 TEMPORARY SERVICES

A. Contractor shall provide a complete temporary light and power service in accordance with requirements of specification section 260016 - Temporary Electric Power.

1.12 CONTINUITY OF UTILITY SERVICES

A. It is of paramount importance that each utility service operate continuously and without interruption. Whenever this contractor plans to make changes or alterations to any existing utility service, such plans shall result in no or minimum service interruption or inconvenience to Owner. This contractor shall plan and schedule any change or alteration to an existing utility service with Architect and Owner. Such planning, timing, and/or scheduling shall be approved by both these parties.

1.13 CODES AND STANDARDS

A. New York State Uniform Fire Prevention and Building Code: Provide all work in compliance with and meet the requirements of the latest issue.

B. National Electrical Code: All work covered under these Contract Documents shall conform to the latest issue of the National Electrical Code.

C. Standards: All equipment shall meet all the requirements of ANSI, NEMA, IES, and IEEE standards.

D. Listing: All equipment and devices for which Underwriters' Laboratory has a listing service, shall be UL listed and bear the UL listing label.

E. All materials and installation shall comply with:

1. Building Code of New York State.
2. Energy Conservation Construction Code of New York State.
3. Fire Code of New York State.
4. National Fire Protection Association (NFPA).
5. New York State Department of Labor Rules and Regulations.
6. The Americans with Disabilities Act.
7. Local Utilities.
8. New York State Department of Health.

9. Local Municipality/City Codes and Ordinances and the Authority Having Jurisdiction.
10. Local Fire Department.
11. Insurance Carrier.
12. New York State Department of Education.

1.14 SUBMITTALS & SUBMISSION REQUIREMENTS

A. All submittals shall be in accordance with Division 1 requirements, the following requirements listed below, and also as indicated in each specification section. All submittals not complying with the listing above will be returned to the contractor without being reviewed. Rejection by Architect or Engineer of any items submitted shall require resubmittal of acceptable items.

1. Within (30) days after receiving signed contract or notice to proceed, submit to Architect for review complete descriptive dimensional data and ratings for equipment and materials proposed to be furnished and installed. Submit (8) copies of data unless otherwise specified by the architect.

2. All materials submitted shall clearly state the job name and specification section(s) that it applies to.

3. Any package containing more than one piece of equipment or material shall also contain a schedule clearly listing all items in submittal. Schedule page (s) shall also indicate project name and building name.

4. All submittals must be clearly marked using nomenclature used in this specification for proper item identification, schedule of usages, model numbers, construction materials, performance, data, etc.

5. Projects involving multiple buildings must have the submittals separated by building. Submittals in which buildings are combined will not be accepted. (Exception: When specifically approved by engineer, basic materials may be submitted once.)

6. The Contractor shall insure that dimensions of equipment to be used conform to the space allocated for the equipment on the drawings.

7. Submittals traced or copied from contract drawings are not acceptable and will be returned without review.

8. In the event material and/or equipment is installed prior to obtaining approval of shop drawings, and in the sole opinion of the Owner's Agent, this material and/or equipment does not meet the specifications, the Contractor shall be liable for the removal and the replacement at no additional cost to the contract.

B. Samples: When requested by Engineer, provide samples of both specified equipment and proposed substitutions for review by the Owner's Agent. Such equipment shall be delivered to a location designated or erected at the job site as directed. When neither is physically possible, arrange for the Owner's Agent to visit an acceptable site where the proposed equipment can be inspected.

C. Substitutions:

1. Submittals for equipment or materials other than as specified shall be accepted for review by the Owner's agent.

2. Approval of substitute equipment shall be based on functional, physical and aesthetic compatibility to the equipment specified as determined by the Owner's agent and approved by the engineer.

3. Where substitute equipment is approved, the contractor shall be responsible for, and bear the cost of any necessary changes by his trade or other trades to make the system complete and operable.

4. Contractor is fully responsible for providing coordination between all trades affected by equipment substitution.

5. When requested, contractor shall submit layout drawings indicating new dimensions and arrangements of substituted equipment. Layout drawings shall indicate all revisions necessary for all services affected by substitution.

1.15 FIELD INSPECTION

A. As there are various conditions at the site which do not show on the accompanying drawings, or which are at variance with the conditions indicated on the drawings, it is important that each bidder visit the site and acquaint himself with existing conditions and take these conditions into consideration when preparing his proposal. Each bidder shall obtain information or make any measurement desired. Lack of knowledge relative to existing conditions will not be allowed as a basis for extra compensation.

B. This contractor and his subcontractors shall inspect existing equipment to remain prior to any of his new work in order to determine that all equipment is in good operating condition. If equipment is found to be lacking components, is inoperable, damaged, etc., contractor shall provide immediate written notice to the Owner. The Owner or his representative shall determine if any additional work is necessary and the method by which any work shall be performed.

1.16 PERMITS, CERTIFICATES AND FEES

A. This Contractor shall obtain and pay for permits, certificates, fees etc. listed below. Costs for permits, fees etc. shall be included in the base bid amount.

1. All required applications and permits to begin work.
2. Certificate of inspection including Third-Party Agency.
3. All municipal connection charges.
4. All local utility charges (power, telephone, cable, etc.).
5. Fees and charges shall be obtained directly from the respective authority having jurisdiction.

1.17 GUARANTEE

A. Contractor shall guarantee all work furnished through this contract including work performed by sub-contractors, for a period of (1) year (unless otherwise noted), from the date of final acceptance. Contractor agrees to repair or replace any defective work or materials at no additional cost to the Owner. Contractor shall also pay for any damage to other work resulting from repairs to defects. Contractor shall furnish written guarantees to the Owner's agent in accordance with the general conditions.

1.18 TESTING AND INSPECTION

A. Inspections required for any ordinances, regulations, instructions, laws, rules, standards and practices that require any work to be inspected or tested shall be performed. Contractor shall give Owner, Architect and Engineer timely notice of readiness of work for inspection or testing and the date fixed for said inspection or testing.

B. Third-Party Agency must inspect completed installation and present Owner with Certificate of Inspection showing approval.

C. Required local or municipal inspection. Process and present Owner with certificate indicating approval of such governing bodies.

D. Contractor shall submit a written report to Architect, copy to Engineer, on results of each inspection or test on system or equipment supplied. Report shall contain all pertinent information, recommendations, approvals, additional work required, etc.

E. Contractor is responsible to check rotation on all three-phase equipment prior to turning on equipment for temporary or permanent use.

F. Panelboard, Circuit Breaker, Transformer and Fuse Tests:

1. Energize all possible lighting and equipment loads for a period of not less than eight hours.
2. Check all fuses and circuit breakers for faulty tripping and excessive heat.
3. Tabulate phase current on all feeders.
4. Tabulate voltages at each panelboard (phase to phase and phase to neutral).
5. Reconnect branch circuits that vary over 5% between high and low current.
6. Reconnect transformer taps as required to adjust for high or low voltages.
7. All tabulation sheets shall be presented to the Architect for approval, make any corrections determined by the Architect.

1.19 RECORD DOCUMENTS

A. When required by general conditions or other Division 1 Section this Contractor shall prepare and turn over to Owner's agent record as-built documents. As-built drawings will include actual equipment location layout, service connections, etc.

B. In all projects, contractor shall provide record drawings of all underground equipment and service runs. As-built drawings for underground work will include dimensions to actual locations finish grade elevations, and actual invert to underground structures equipment and service runs.

1.20 PENETRATIONS THRU FIRE RATED CONSTRUCTION

A. All penetrations by this contract through rated construction shall be sealed fire safe by a UL listed approved method.

B. All electrical penetrations through walls, floors, etc. shall be conduit sleeved.

C. All conduit penetrations through fire rated partitions, walls, floors, etc. shall be installed as follows; penetration shall be oversized 1/2" to 3/4" maximum. This Contractor shall pack with fireproofing insulation, type FS cerablanket. Outside of penetrations shall be caulked and sealed with flame stop V, as manufactured by Flame Stop, Inc.; or an approved equal. Flame stop sealant shall be troweled smooth for finishing as required.

1.21 CONFINED SPACES

A. All work in pipe tunnels, mechanical pits, well manholes, etc. shall be performed by skilled tradesman and laborers with current certification for working in confined space. Contractor shall bear all costs to provide all safety equipment, ventilation, etc. as required by State and Federal Regulations and shall obtain all necessary permits for such work.

B. Contractor shall submit copy of current certifications and photo I.D. of all tradesman and laborers who will be working in confined spaces on this project.

1.22 INTENT OF DRAWINGS

A. The drawings are diagrammatic, unless detailed dimensioned drawings are included. Drawings show approximate locations of equipment, fixtures, panelboards, and wiring devices. Exact locations are subject to the approval of the Owner's Representative. The general run of electrical feeders, branch circuits, and conduits, indicated on the drawings, is not intended to be the exact routing. Circuit designations, in the form of "Home Runs" on branches, indicate the designation of the branch circuit, and the panelboard or interconnection box from which the branch circuit is served.

B. Drawings show general design and arrangement. Verify exact location and elevations at the job location. Do not scale plans and diagrams.

C. Drawings do not show all offsets, fittings, interferences, and elevation changes. Adjust installation of conduit, equipment location, etc. to accommodate work with the obstacles and interferences. Where a major and important rearrangement is necessary, report same to Architect for review. Obtain written approval for all major changes.

D. Prior to roughing in any back boxes for power or communications devices, thoroughly examine the architectural elevations, enlarged plans and details. Also exam vendor drawings and manufacturer instructions for equipment furnished by others or as part of this contract. Install back boxes in locations and at heights as indicated on these documents. If the locations are not detailed, issue an RFI to the construction manager to obtain them. Boxes that are roughed in without detailed location and heights will re-located at no additional cost to the contract by the electrical contractor.

E. Cooperate with all Contracts and Owners and determine the exact route of all raceway and location of all equipment.

1.23 COORDINATION DRAWINGS

A. Before construction work commences, Contractors for all trades shall submit Coordination Drawings at not less than 1/4" = 1'-0" scale. Coordination Drawings are required throughout all areas for all trades. These drawings shall identify and show resolutions of trade conflicts. Mechanical Equipment Rooms shall be drawn early in the Coordination Drawing process, simultaneous with all other congested areas. Prepare Coordination Drawings As Follows:

1. HVAC Contract will prepare the base plan Coordination Drawings showing all ductwork and all pertinent piping and equipment. These drawings may be CAD drawings of the required ductwork Shop Drawings. The drawings shall be coordinated with cable tray, lighting fixtures, air diffusers, other ceiling mounted items, ceiling heights, structural work, maintenance clearances, electric code clearance, reflected ceiling plans, and other contract requirements. Reposition proposed locations of work after coordination drawing review by the Construction Manager and the Architect. Provide adjustments to exact size, location and offsets of ducts, pipes, conduit, etc., to achieve reasonable appearance objectives. Provide these adjustments as part of Base Bid Contracts. Minor revisions need not be redrawn.

2. HVAC Contract will provide prints and Cad drawings and submit the base plan to all major trades' Contractors.

3. Electrical, Plumbing and Fire Protection Contracts will draft location of piping and equipment on the base plan, indicating areas of conflict and suggested resolutions.

PART 2 - PRODUCTS

2.01 MATERIALS

A. All materials, unless otherwise specified, shall be new and be the standard products of the manufacturer. Used equipment or damaged material will be rejected.

B. The listing of a manufacturer as “acceptable” does not indicate acceptance of a standard or catalogued item of equipment. All equipment and systems conform to the Specifications.

2.02 U.L. LISTING

A. Equipment shall bear the Underwriter’s Laboratories (UL), or other approved agency listing label. This listing requirement applies to the entire assembly. Any modifications to equipment to suit the intent of the specifications shall be performed in accordance with the National Electric Code and listed by U.L.

2.03 FIRE STOPPING

A. Fire-stopping for Openings through Fire and Smoke Rated Walls and Floor Assemblies shall be listed or classified by an approved independent testing laboratory for "Through-Penetration Fire-Stop Systems." The system shall meet the requirements of "Fire Tests of Through-Penetration Fire-Stops" designated ASTM E814.

B. Acceptable Manufacturers:

1. Dow Corning Fire-Stop System Foams and Sealants.
2. Nelson Electric Fire-Stop System Putty, CLK and WRP.
3. Thomas & Betts - S-100 FS500/600.
4. Carborundum Fyre Putty.
5. Hilti Firestop Systems.

PART 3 - EXECUTION

3.01 ROUGHING

A. Obtain approved roughing diagrams and exact locations of equipment for items furnished under other Divisions of the specifications. Do not rough in without approved drawing.

B. Due to small scale of Drawings, it is not possible to indicate all offsets, fittings, changes in elevation, etc. Verify final locations for rough-ins with field measurements and with the equipment being connected. Verify exact location and elevations at work site prior to any rough in work. DO NOT SCALE PLANS. If field conditions, details, changes in equipment or shop drawing information require a significant change to the original documents, contact the owners’ representative for approval before proceeding.

C. All equipment locations shall be coordinated with other trades to eliminate interference with required clearances for equipment maintenance and inspections.

D. Coordinate work with other trades and determine exact routing of all duct, pipe, conduit, etc., before fabrication and installation. Coordinate with Architectural Drawings. Verify with Owner's Representative exact location of all equipment in finished areas, such as thermostat, fixture and switch mounting heights, and equipment mounting heights. Coordinate all work with the architectural reflected ceiling plans and/or existing Architecture. Mechanical and electrical drawings show design arrangement only for diffusers, grilles, registers, air terminals, lighting fixtures, sprinklers, speakers and other items. Do not rough-in contract work without reflected ceiling location plans.

E. Before roughing for equipment furnished by Owner or in other contracts, obtain from Architect and other Contractors, approved roughing drawings giving exact location for each piece of equipment. Do not "rough in" services without final layout drawings approved for construction. Cooperate with other trades to insure proper location and size of connections to insure proper functioning of all systems and equipment. Obtain written authorization from the Owners representative or other contractor for any “rough ins” that, due to project schedule, are required before approved coordination drawings are available. Any work installed without written authorization or approved coordination drawings, causing a conflict will be relocated by the electrical contractor at no expense to the Owner.

F. For equipment and connections provided in this contract, prepare roughing drawings as follows:

1. Existing equipment being relocated: Measure the existing equipment and prepare drawings for installation in new location.

2. New equipment: Obtain equipment roughing drawings and dimensions, then prepare rough-in drawings.

3. Where more than one trade is involved in an area, space or chase, all shall cooperate and install their own work to utilize the space equally between them in proportion to their individual requirements. In general, ductwork shall be given preference except where grading of piping becomes a problem, followed by piping then electrical wiring. If, after installation of any equipment, piping, ducts, conduit, and boxes, it is determined that ample maintenance and passage space has not been provided, rearrange work and/or furnish other equipment as required for ample maintenance space. Any changes in the size or location of the material or equipment supplied, which may be necessary in order to meet field conditions or in order to avoid conflicts between trades, shall be brought to the immediate attention of the Owner's Representative and approval received before such alterations are made.

4. Provide easy, safe, and code mandated clearances at controllers, motor starters, valve access, and other equipment requiring maintenance and operation. Contractor shall relocate existing work in the way of new construction. VISIT SITE BEFORE BIDDING TO DETERMINE SCOPE OF WORK. Provide new materials, including new piping and insulation for relocated work.

3.02 CUTTING AND PATCHING

A. This contractor shall bear the cost of all cutting and patching required by and for the installation of this work. This contractor shall perform all cutting and patching unless otherwise indicated on drawings or if directed by the Architect.

B. Patching of fire rated floors, walls, partitions, etc. shall be made using new materials equal to the fire rating of the existing.

C. Should changes, omissions or errors in electrical work require cutting, patching or making alterations in any portion of new construction, such work will be performed by GC at contractor's expense.

D. Cutting and patching of roof surfaces and structures shall only be performed by a qualified contractor, as approved by the Architect. The work of this contract shall bear the cost of above mentioned cutting and patching. This contractor shall insure that existing roof warranties remain in force.

E. This contractor shall furnish lintels, sized to accommodate structure above opening, where cutting and patching is to be performed on load bearing walls. Contractor shall obtain written approval for all lintels prior to installation.

F. Cutting shall be done in a manner which will not adversely affect the strength of the building. Holes and openings shall be neatly cut so as to provide a finished appearance and shall be patched around the edge where required for a finished appearance. Provide temporary bracing, shoring, etc. as required.

G. Patching shall be structurally sound and match the existing materials and finish of adjacent materials. Patching is required in finished areas, wherever existing work is removed, at the sides of openings, etc. Patching shall include repairs, painting, etc.

H. At the completion of the work, all evidence of alteration will be as inconspicuous as possible.

3.03 OPENINGS, SLEEVES, AND CHASES

A. Certain chases, openings, and shafts will be provided as shown as part of General Construction Plans and Specifications.

B. Provide all other openings and sleeves for conduit etc. through floors, walls, partitions, ceilings, roofs, etc. for Division 26-E work.

C. Assume responsibility for correct and final location and size of such openings; furnish templates if required. Correct improperly located and sized or omitted chases and openings as required. Plug all abandoned sleeves left as part of this Contract.

3.04 SEALING AND FIRESTOPPING

A. Installation of Fire-stopping for Openings Through Fire and Smoke Rated Walls and Floor Assemblies shall be as follows:

1. Provide fire-stop system seals at all locations where piping, tubing, conduit, electrical busways/cables/wires, ductwork and similar utilities pass through or penetrate fire rated wall or floor assembly. Provide fire-stop seal between sleeve and wall for dry wall construction.

2. The minimum required fire resistance ratings of the wall or floor assembly shall be maintained by the fire-stop system. The installation shall provide an air and watertight seal.

3. The methods used shall incorporate qualities that permit the easy removal or addition of electrical conduits or cables without drilling or use of special tools. The product shall adhere to itself to allow repairs to be made with the same material and permit the vibration, expansion and/or contraction of any items passing through the penetration without cracking, crumbling and resulting reduction in fire rating.

4. Provide rigid steel sleeves where non-armored cables pass through fire rated walls and barriers.

3.05 SUPPORTS

A. Provide required supports for work of this Contract, including beams, angles, channel, hangers, rods, columns, plates, bases, braces, etc. to properly support all work.

B. Provide steel angles, channels and other materials necessary for the proper support and erection of motor starters, distribution panelboards, large disconnect switches, pendant-mounted lighting fixtures, etc.

C. Panelboards, cabinets, large pull boxes, cable support boxes and starters shall be secured to ceiling and floor slab and not supported from conduits. Small panelboards, etc., as approved by Owner's Representative, may be supported on walls. Racks for support of conduit and heavy electrical equipment shall be secured to building construction by substantial structural supports.

D. Provide concrete bases for all floor mounted equipment. Provide 3,000 lb. concrete, chamfer edges, trowel finish, securely bond to floor by roughening slab and coating with cement grout. Bases 2" high; shape and size to accommodate equipment. Set anchor bolts in sleeves before pouring and after anchoring and leveling, fill equipment bases with grout.

E. See Specification Section 260530 – Supporting Devices for additional requirements

3.06 CONCEALMENT

A. Unless otherwise specifically indicated, all work shall be concealed above ceiling space, in wall space, below slabs in crawl spaces, and elsewhere throughout the building.

B. In areas with no ceilings, install only after Architect reviews and comments on arrangement and appearance.

3.07 TEMPORARY LIGHT AND POWER

A. Provide temporary electric system as called for in specification section 260016.

3.08 ROOF AND ROOF DECK CUTTING AND FLASHING

A. All penetrations through roofing and decking shall be accomplished by the roofing manufacturer‘s Certified Roofing Contractor in order to maintain roof system warranty.

3.09 EQUIPMENT INSTALLATION

A. All installations shall comply with the following requirements:

1. Provide code required disconnects for all electrical equipment that is furnished or connected by the electrical contractor.

2. Coordinate electrical systems, equipment, and materials installation with other building components. Be responsible for any changes in openings and locations necessitated by the equipment installed.

3. The architect shall control the placement of all wall and ceiling mounted electrical equipment and devices in all rooms with the exception of mechanical and electrical equipment rooms. When drawing details are not available, consult with the Architects representative for actual location.

4. Verify all dimensions with field measurements.

5. Arrange for all chases, slots and openings in other building components that are not indicated on drawings, to allow for electrical installations.

6. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

7. Coordinate ordering and installation of all 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 construction schedule. Pay close attention to equipment that must be installed prior to building enclosure.

8. Where mounting heights are not detailed or dimensioned, install systems, materials and equipment to provide the maximum headroom possible.

9. Install systems, materials and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer the conflict to the Architect.

10. Store Materials on dry base, at least 6" above-ground or floor. Store so as not to interfere with other work or obstruct access to buildings or facilities. Provide waterproof/windproof covering. Remove and provide special storage for items subject to moisture damage. Protect against theft or damage from any cause. Replace items stolen or damaged, at no cost to Owner.

11. Set all equipment to accurate line and grade, level all equipment and align all equipment components.

12. All tolerances in alignment and leveling, and the quality of workmanship for each stage of work shall be as required by the manufacturer and subject to approval by the owners representative.

13. All finished equipment surfaces damaged during construction shall be brought to “as new” condition by touch up or repainting. Any rust shall be removed and primed prior to repainting.

14. Workmanship shall be as called for in the “Standard of Installation” published by the National Electrical Contractors Association (NECA).

15. Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery of equipment and apparatus furnished into the premises. These items shall be removed from premises when no longer required.

16. No electrical equipment shall be hidden or covered up prior to inspection by the owners’ representative. All work that is determined to be unsatisfactory shall be corrected immediately.

17. All electrical work shall be installed level and plumb, parallel and perpendicular to other building systems and components.

18. Conceal all contract work above ceilings and in walls, below slabs, and elsewhere throughout building. If concealment is impossible or impractical, notify Owner's Representative before starting that part of the work and install only after his approval. In areas with no ceilings, install only after Owner's Representative reviews and comments on arrangement and appearance.

19. Install access panel or door where units are concealed behind finished surfaces.

B. Provide complete power connections to all electrical equipment. Provide control connections to equipment where indicated on the drawings. Provide disconnect ahead of each piece of equipment. Ground all equipment in accordance with the latest version of the National Electrical Code.

C. Provide all power wiring, electric equipment, control wiring, switches, lights, receptacles, and connections as required for proper equipment operation of Owner-Furnished Equipment and Equipment furnished by other contracts,

D. Refer to Manufacturer's drawings/specifications for requirements of special equipment. Verify connection requirements before bidding and confirm prior to roughing.

E. This contractor shall coordinate scheduling and installation of work with other contractors, sub-contractors and other trades. The contractor is also required to coordinate all work with owner supplied materials, direct contracts, and normal building operations, if any.

F. All finished work shall be neat and workmanlike. All work of a special nature shall be performed by skilled and qualified workmen who can present credentials showing experience in said trade. New systems shall be delivered to Owner complete in perfect working order, tested and balanced in full accordance with plans and specifications. Existing systems shall function in same manner as before this work was performed. Any malfunctions which arise in existing systems as a result of demolition or alteration of parts of such systems shall be corrected.

G. Layout of equipment, accessories and electrical systems in plan is generally diagrammatic unless specifically dimensioned or detailed. Check project drawings and existing site conditions before installing work for interferences as governed by structural or other conditions. Owner reserves the right to make reasonable changes in location of equipment, accessories or electrical systems prior to "roughing-in" without involving additional expense. Exact dimensions shown upon plans will be subject to verification and confirmation of exact conditions at site at time of construction. "Plus or minus" dimensions are shown upon drawing as a guide only. Exact surrounding conditions are governed by final equipment selection and/or other like details.

H. Furnish all new equipment and materials as described herein. Any material, operation, method or device mentioned, listed or noted within this specification, if not specifically mentioned as furnished or installed by others, shall be furnished and installed by this contractor.

3.10 REMOVAL OF BALLAST IN EXISTING LIGHT FIXTURE

A. Assume ballasts contain PCB materials unless labeled otherwise, or test samples to show materials are not PCB; submit test report. Remove all ballasts from existing light fixtures indicated on contract documents. Dispose of all ballasts which do not have non-PCB labels in PCB containers and pay all costs to have containers taken to EPA-approved incinerators and disposed of per all EPA regulations. Follow all EPA regulations for transporting containers and materials. If ballast has leaked in existing fixture, remove material deposited in fixture, and dispose of those materials as listed above. Provide Certificate of Disposal and all associated paperwork to Owner’s Representative.

3.11 FIRE ALARM DETECTOR COVERS

A. Electrical Contractor is responsible to provide dust covers on all detectors whether new or existing in any area of construction. This shall be done in any area of construction even if there is no electrical work being done in this area. Coordinate with all trades.

3.12 ROOF PENETRATIONS

A. Electrical Contractor is to refer to Division 7 for warranty requirements on existing roofs prior to any roof penetrations made.

3.13 PAINTING

A. This Contract Includes the following:

1. Painting for all cut and patch work performed as part of Division 26 contract.

2. Painting required for touch-up of surfaces damaged due to the installation of electrical work.

3. Painting as required to repair finish of equipment furnished.

4. Painting of all surface mounted raceways in finished areas.

3.14 CLEANING

A. After all tests are made and installations completed satisfactorily:
B. Thoroughly clean entire installation, both exposed surfaces and interiors.
C. Remove all debris caused by work.
D. Remove tools, surplus, materials, when work is finally accepted.

3.15 CONTINUITY OF SERVICES

A. The building will be in use during construction operations. Maintain existing systems in operation within all rooms of building at all times. Refer to "General Conditions of the Contract for Construction" for temporary facilities for additional contract requirements. Schedules for various phases of contract work shall be coordinated with all other trades and with Owner's Representative. Provide, as part of contract, temporary mechanical and electrical connections and relocation as required to accomplish the above. Obtain approval in writing as to date, time, and location for shut-down of existing mechanical/electrical facilities or services.

3.16 START UP AND OWNER INSTRUCTIONS

A. Before acceptance of the work, furnish necessary skilled labor to operate all systems by seasons. Instruct the Owners designated personnel on the proper operation and maintenance of systems and equipment. Obtain written acknowledgment from person instructed prior to acceptance repeat the instructions if asked to do so. Contractor is fully responsible for systems until acceptance, even though operated by Owner's personnel, unless otherwise agreed in writing. Provide, operating, maintenance and starting precautions and procedures to be followed by the Owner for operating systems and equipment. Mount the instruction in clear plastic holder on or adjacent to the equipment.

B. Where supervision by a manufacturer is called for, provide manufacturer’s certified technician or engineer to supervise the startup, testing and adjustment of the equipment or system. Where two or more manufacturer’s are involved (i.e., variable frequency drive and air handling unit) both manufacturer’s shall be present at start up. The manufacturer shall provide a written report detailing the testing and start-up including problems that occurred and their method of resolution.

C. Training Session: A training session shall be held for each system and/or item listed below:

Item	Description	Training Hours for Each Bldg.
1.	Lighting Control System	1

D. The instruction shall include the following types of information:

1. System overview
2. Major component designation
3. System operation procedures
4. Maintenance scheduling and procedures
5. Provide a list of spare components each system would normally require

E. Services: Provide services required, for all equipment specified under this contract, for a period of (1) year after written acceptance by the Owner.

3.17 OPERATION AND MAINTENANCE MANUALS

A. Provide Operation and Maintenance Manuals. For projects containing multiple buildings, manuals shall be submitted separately for each building. Include the following:

1. As-Built drawings.
2. Equipment wiring diagrams.
3. Manufacturer's instructions.
4. Include typewritten instructions, describing equipment, starting/operating procedures, and Emergency operating instructions.
5. Recommended maintenance procedures.
6. Include name, address, and telephone number of supplier manufacturer.
7. Representative and service agency for all major equipment items.
8. Panel schedules in hard copy and word or excel format.
9. Bind above items in a three-ring binder with name of project on the cover.
10. Provide CD or DVD with all data in word, pdf, or excel format.

B. Refer to specific specification electrical specification sections for additional requirements.

C. Deliver to Owner's Representative before request for acceptance.

3.18 ASBESTOS RECOGNITION AND PRECAUTIONS

A. The contractor shall be responsible for coordination of all required removal work, coring, cutting and patching with the owners asbestos management plan. Prior to performing such work identify areas containing asbestos. Notify the Owner so that they may make arrangements for abatement and/or containment prior to work proceeding. The contractor shall be responsible for cleaning all areas where asbestos is released due to the failure to coordinate with the asbestos management plan. Refer to Division 1 sections for further requirements.

B. The disturbance or dislocation of asbestos-containing materials causes asbestos fibers to be released into the building's atmosphere, thereby creating a health hazard to workmen and building occupants. Consistent with Industrial Code Rule 56 and the content of recognized asbestos-control work, the Contractor shall apprise all of his workers, supervisory personnel, subcontractors, Owner and Consultants who will be at the job site of the seriousness of the hazard and of proper safeguards and work procedures which must be followed, as described in New York State Department of Labor Industrial Code Rule 56.

END OF SECTION

SECTION 260015 - ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract including the General and Supplementary Conditions of Division 1 of the Specification Sections, apply to the work of this section.

1.02 SECTION INCLUDES

A. Interior demolition, removal and abandonment of interior electrical systems including fire alarm.

B. Cleaning and repair of existing equipment to remain.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching work: As specified in individual sections.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Prior to beginning work inspect and test all existing electrical systems that will be affected by the work in this contract. Provide a report to the Owner indicating any problems or defects found. If no problems or system defects are submitted, the contractor shall be responsible for correcting problems found at the completion of the project that are determined to be caused by the work of this contract.

B. Inspect the entire work area for defects in the existing construction such as scratches, holes etc. Submit a complete list and photographs of existing damage, to the owner prior to beginning work. If existing damage is not documented the contractor shall repair all damage to like new condition, that is determined to have been caused by the work in this contract.

C. Verify circuiting arrangements are as shown on Drawings.

D. Verify that abandoned wiring and equipment serve only abandoned facilities.

E. Demolition Drawings are based on casual field observation and existing record documents. Report discrepancies to Architect/Engineer before disturbing existing installation.

F. Beginning of demolition means installer accepts existing conditions.

3.02 PREPARATION

A. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.

B. Provide temporary wiring and connections to maintain existing systems in service during construction.

C. Existing Fire Alarm System: Maintain existing system in service and minimize outage duration for relocation. Disable system only to make switchovers and connections. Notify Owner, Architect/Engineer, and local fire service at least (72) hours before partially or completely disabling system.

3.03 DEMOLITION EXISTING ELECTRICAL WORK

A. Demolish existing electrical work under provisions of Division 01, Division 02 and this section.

B. Remove existing installations to accommodate requirements for new construction.

C. Remove abandoned wiring to source of supply.

D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

E. Disconnect abandoned outlets and remove devices. Provide blank cover for abandoned outlets which are not removed.

F. Disconnect and remove abandoned panelboards and distribution equipment.

G. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

H. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.

I. Repair adjacent construction and finishes damaged during demolition work.

J. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.

K. Where branch circuit home run is called to be reused label circuit in junction box and remove all branch and switch leg wiring.

L. Where removal of branch circuit wiring effects devices or fixtures upstream or downstream, make permanent connections to maintain circuits. Existing circuits to must remain active. All required connections to maintain existing circuits must be made after normal hours and coordinated with the owner.

3.04 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment which remain or are to be reused.

B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

C. Luminaires: Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps and broken electrical parts.

END OF SECTION

SECTION 260016 - TEMPORARY ELECTRIC POWER

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the contract including the General and Supplementary conditions and Division 1 Specification Sections apply to the work of this Section.

1.02 SUBMITTALS

A. Not Required.

1.03 GENERAL REQUIREMENTS

A. Electrical Contractor shall furnish, install and maintain temporary electric system for lighting and power as described herein.

B. All temporary electric system work shall comply with all applicable OSHA Standards.

C. All temporary electric system work shall comply with all applicable N.E.C. Standards and local regulations.

D. Power shall be supplied from the source listed below.

E. Temporary service shall be installed on the jobsite where appropriate for the level of construction and as directed by Architect.

F. Temporary service and all devices and wiring shall be removed from the site when permanent facilities are available and as directed by Architect.

G. Temporary services including wire and cabling shall not interfere or impede movement of construction vehicles.

H. Contractor shall provide all maintenance necessary for continuous operation for temporary electric system throughout the duration of system operation.

PART 2 - PRODUCTS

NONE

PART 3 - EXECUTION

3.01 TEMPORARY LIGHTING

A. Provide temporary branch circuits with weatherproof medium base lamp holders equipped with guards for lighting of 10 foot-candles in work area. Provide replacement lamps where required for the duration of system operation.

B. Provide temporary lighting in all work areas.

C. Provide temporary lighting for corridors, walk areas, stairs, etc. for safe entrance and egress.

D. Provide temporary lighting as required for security purposes for building exterior and applicable site locations and building interior locations.

E. Provide lighting in specific areas as directed by Architect.

3.02 TEMPORARY CONVENIENCE POWER

A. Provide temporary convenience power distribution for the use of tradesman hand tools and other devices as requested by construction trades.

B. Branch circuits with GFCI type receptacle outlets for single phase 120-volt, 20-amp power.

C. Convenience power distribution shall cover all work areas of building within a 100' extension cord reach. Each contractor using power shall provide their own ground fault device protection.

3.03 TEMPORARY EQUIPMENT POWER

A. Provide temporary equipment power feeds for temporary heating equipment. Temporary heating equipment shall be furnished by others.

B. Branch circuits for heating equipment shall be connections with single phase 208-volt, 30-amp power. Coordinate exact locations with HC.

3.04 WIRE AND CABLES

A. Interior Locations: Lighting circuits shall utilize suspended open type festoon style wiring. Power circuits shall be run flexible or rigid conduit as appropriate for each application.

END OF SECTION

SECTION 260190 - SUPPORTING DEVICES

PART 1 -GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract including the General and Supplementary Conditions of Division 1 of the Specification Sections, apply to the work of this section.

1.02 SECTION INCLUDES

A. Conduit and equipment supports.
B. Anchors and fasteners.

1.03 REFERENCES

A. Refer to Division 1.
B. NECA Standard of Installation (National Electrical Contractors Association).
C. NFPA 70 - National Electrical Code.

1.04 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.01 ANCHORING DEVICES

A. Sleeve Anchors (FS FF-S-325 Group II, Type 3, Class 3): Molly/Emhart's Parasleeve Series, Phillips' Red Head AN, HN, FS Series, or Ramset's Dynabolt Series.

B. Wedge Anchors (FS FF-S-325 Group II, Type 4, Class 1): Hilti's Kwik Bolt Series, Molly/Emhart's Parabolt Series, Phillips' Red Head WS, or Ramset's Trubolt Series.

C. Self-Drilling Anchors (FS FF-S-325 Group III, Type 1): Phillips' Red Head Series S or Ramset's Ram Drill Series.

D. Non-Drilling Anchors (FS FF-S-325 Group VIII, Type 1): Hilti's Drop-In Anchor Series, Phillips' Red Head J Series, or Ramset's Dynaset Series.

E. Stud Anchors (FS FF-S-325 Group VIII, Type 2): Phillips' Red Head JS Series.

2.02 CAST-IN-PLACE CONCRETE INSERTS

A. Continuous Slotted Type Concrete Insert, Galvanized:

1. Load Rating 1300 lbs./ft.: Kindorf's D-986.
2. Load Rating 2400 lbs./ft.: Kindorf's D-980.
3. Load Rating 3000 lbs./ft.: Hohmann & Barnard Inc.'s Type CS-H.
4. Load Rating 4500 lbs./ft.: Hohmann & Barnard Inc.'s Type CS-HD.

B. Threaded Type Concrete Insert: Galvanized ferrous castings, internally threaded.

C. Wedge Type Concrete Insert: Galvanized box-type ferrous castings, designed to accept bolts having special wedge-shaped heads.

2.03 MISCELLANEOUS FASTENERS

A. Except where shown otherwise on the Drawings, furnish type, size, and grade required for proper installation of the Work, selected from the following: Furnish galvanized fasteners for exterior use, or for items anchored to exterior walls, except where stainless steel is indicated.

1. Standard Bolts and Nuts: ASTM A 307, Grade A, regular hexagon head.
2. Lag Bolts: FS FF-B-561, square head type.
3. Machine Screws: FS FF-S-92, cadmium plated steel.
4. Machine Bolts: FS FF-B-584 heads; FF-N-836 nuts.
5. Wood Screws: FS FF-S-111 flat head carbon steel.
6. Plain Washers: FS FF-W-92, round, general assembly grade carbon steel.
7. Lock Washers: FS FF-W-84, helical spring type carbon steel.
8. Toggle Bolts: Tumble-wing type, FS FF-B-588, type, class and style as required to sustain load.

B. Stainless Steel Fasteners: Type 302 for interior Work; Type 316 for exterior Work; Phillips head screws and bolts for exposed Work unless otherwise specified.

2.04 HANGER RODS

A. Mid low carbon steel, unless otherwise specified; fully threaded or threaded each end, with nuts as required to position and lock rod in place. Unless galvanized or cadmium plated, provide a shop coat of red lead or zinc chromate primer paint.

2.05 "C" BEAM CLAMPS

A. With Conduit Hangers:

1. For 1 Inch Conduit Maximum: B-Line Systems Inc.'s BG-8, BP-8 Series, Caddy/Erico Products Inc.'s BC-8P and BC-8PSM Series, or GB Electrical Inc.'s HIT 110-412 Series.

2. For 3 Inch Conduit Maximum: Appleton Electric Co.'s BH-500 Series beam clamp with H50W/B Series hangers, Kindorf's 500 Series beam clamp with 6HO-B Series hanger, or OZ/Gedney Co.'s IS-500 Series beam clamp with H-OWB Series hanger.

3. For 4 Inch Conduit Maximum: Kindorf's E-231 beam clamp and E-234 anchor clip and C-149 series lay-in hanger; Unistrut Corp.'s P2676 beam clamp and P-1659A Series anchor clip with J1205 Series lay in hanger.

B. For Hanger Rods:

1. For 1/4 Inch Hanger Rods: B-Line Systems Inc.'s BC, Caddy/Erico Products Inc.'s BC, GB Electrical Inc.'s HIT 110, Kindorf's 500, 510, or Unistrut Corp.'s P1648S, P2398S, P2675, P2676.

2. For 3/8 Inch Hanger Rods: Caddy/Erico Products Inc.'s BC, Kindorf's 231-3/8, 502, or Unistrut Corp.'s P1649AS, P2401S, P2675, P2676.

3. For 1/2 Inch Rods: Appleton Electric Co. BH-500 Series, Kindorf's 500 Series, 231-1/2, OZ/Gedney Co.'s IS-500 Series, or Unistrut Corp.'s P1650AS, P2403S, P2676.

4. For 5/8 Inch Rods: Unistrut Corp.'s P1651AS beam clamp and P1656A Series anchor clip.

5. For 3/4 Inch Rods: Unistrut Corp.'s P1653S beam clamp and P1656A Series anchor clip.

2.06 CHANNEL SUPPORT SYSTEM

A. Channel Material: 12 gage steel.

B. Finishes:

1. Phosphate and baked green enamel/epoxy.
2. Pre-galvanized.
3. Hot dipped galvanized.
4. Polyvinyl chloride (PVC), minimum 15 mils thick.

C. Fittings: Same material and finish as channel.

D. UL Listed Systems:

1. B-line Systems Inc.'s B-22 (1-5/8 x 1-5/8 inches), B-12 (1-5/8 x 2-7/16 inches), B-11 (1-5/8 x 3-1/4 inches).

2. Grinnell Corp.'s Allied Power-Strut PS 200 (1-5/8 x 1-5/8 inches), PS 150 (1-5/8 x 2-7/16 inches), PS 100 (1-5/8 x 3-1/4 inches).

3. Kindorf's B-900 (1-1/2 x 1-1/2 inches), B-901 (1-1/2 x 1-7/8 inches), B-902 (1-1/2 x 3 inches).

4. Unistrut Corp.'s P-3000 (1-3/8 x 1-5/8 inches), P-5500 (1-5/8 x 2-7/16 inches), P-5000 (1-5/8 x 3-1/4 inches).

5. Versabar Corp.'s VA-1 (1-5/8 x 1-5/8 inches), VA-3 (1-5/8 x 2-1/2 inches).

2.07 MISCELLANEOUS FITTINGS

A. Side Beam Brackets: B-Line Systems Inc.'s B102, B103, B371-2, Kindorf's B-915, or Versabar Corp.'s VF-2305, VF-2507.

B. Pipe Straps:

1. Two Hole Steel Conduit Straps: B-Line Systems Inc.'s B-2100 Series, Kindorf's C-144 Series, or Unistrut Corp.'s P-2558 Series
2. One Hole Malleable Iron Clamps: Kindorf's HS-400 Series, or OZ/ Gedney Co.'s 14-G Series, 15-G Series (EMT).

C. Deck Clamps: Caddy/Erico Products Inc.'s DH-4-T1 Series.

D. Fixture Stud and Strap: OZ/Gedney Co.'s SL-134, or Steel City's FE-431.

E. Supporting Fittings for Pendent Mounted Industrial Type Fluorescent Fixtures on Exposed Conduit System:

1. Ball Hanger: Appleton Electric Co.'s AL Series, or Crouse-Hinds Co.'s AL Series.

2. Flexible Fixture Hanger: Appleton Electric Co.'s UNJ-50, UNJ-75, or Crouse-Hinds Co.'s UNJ115.

3. Flexible (Hook Type) Fixture Hanger: Appleton Electric Co.'s FHHF, or Crouse-Hinds Co.'s UNH-1.

4. Eyelet: Unistrut Corp.'s M2250.

5. Eyelet with Stud: Kindorf's H262, or Unistrut Corp.'s M2350.

6. Conduit Hook: Appleton Electric Co.'s FHSN, or Crouse-Hinds Co.'s UNH-13.

F. Supporting Fasteners (Metal Stud Construction): Metal stud supports, clips and accessories as produced by Caddy/Erico Products Inc.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Where specific fasteners are not specified or indicated for securing items to in-place construction, provide appropriate type, size, and number of fasteners for a secure, rigid installation.

B. Install anchoring devices and other fasteners in accordance with manufacturer's printed instructions.

C. Make attachments to structural steel wherever possible.

3.02 FASTENER SCHEDULE

A. Material:

1. Use cadmium or zinc coated anchors and fasteners in dry locations.

2. Use hot dipped galvanized or stainless-steel anchors and fasteners in damp and wet locations.

3. For corrosive atmospheres or other extreme environmental conditions, use fasteners made of materials suitable for the conditions.

B. Types and Use: Unless otherwise specified or indicated use:

1. Cast-in-place concrete inserts in fresh concrete construction for direct pull-out loads such as shelf angles or fabricated metal items and supports attached to concrete slab ceilings.

2. Anchoring devices to fasten items to solid masonry and concrete when the anchor is not subjected to pull out loads, or vibration in shear loads.

3. Toggle bolts to fasten items to hollow masonry and stud partitions.

4. TPR fasteners to fasten items to plywood backed gypsum board ceilings.

5. Metallic fasteners installed with electrically operated or powder driven tools for approved applications, except:
   a) Do not use powder driven drive pins or expansion nails.

   b) Do not attach powder driven or welded studs to structural steel less than 3/16 inch thick.

   c) Do not support a load, in excess of 250 lbs from any single welded or powder driven stud.

   d) Do not use powder driven fasteners in precast concrete.

3.03 ATTACHMENT SCHEDULE

A. General: Make attachments to structural steel or steel bar joists wherever possible. Provide intermediate structural steel members where required by support spacing. Select steel members for use as intermediate supports based on a minimum safety factor of 5.

1. Make attachments to steel bar joists at panel points of joists.

2. Do not drill holes in main structural steel members.

3. Use "C" beam clamps for attachment to steel beams.

B. Where it is not possible to make attachments to structural steel or steel bar joists, use the following methods of attachment to suit type of construction unless otherwise specified or indicated on the drawings:

1. Attachment to Steel Roof Decking (No Concrete Fill):
   a) Decking with Hanger Tabs: Use deck clamps.

   b) Decking Without Hanger Tabs:
      (1) Before Roofing Has Been Applied: Use 3/8-inch threaded steel rod welded to a 4 x 4 x 1/4-inch steel plate and installed through 1/2 inch hole in roof deck.
      (2) After Roofing Has Been Applied: Use welding studs, or self-drilling/tapping fasteners. Exercise extreme care when installing fasteners to avoid damage to roofing.

2. Attachment to Concrete Filled Steel Decks (Total thickness, 2-1/2 inches or more):
   a) Before Fill Has Been Placed:
      (1) Use thru-bolts and fish plates.
      (2) Use welded studs. Do not support a load in excess of 250 pounds from a single welded stud.

   b) After Fill Has Been Placed: Use welded studs. Do not support a load in excess of 250 lbs. from a single welded stud.

3. Attachment to Cast-In-Place Concrete:
   a) Fresh Concrete: Use cast-in-place concrete inserts.

   b) Existing Concrete: Use anchoring devices.

4. Attachment to Cored Precast Concrete Decks:
   a) New Construction: Use thru-bolts and fish plates before Construction Work Contractor has placed concrete fill over decks.

5. Attachment to Hollow Block or Tile Filled Concrete Deck:
   a) New Construction: Use cast-in-place concrete inserts by having Construction Work Contractor omitting blocks and pouring solid blocks with insert where required.

6. Attachment to Waffle Type Concrete Decks:
   a) New Construction:
      (1) Use cast-in-place concrete inserts in fresh concrete.
      (2) If concrete fill has been applied over deck, thru-bolts and fish plates may be used where additional concrete or roofing is to be placed over the deck.

7. Attachment to Precast Concrete Planks: Use anchoring devices, except do not make attachments to precast concrete planks less than 2-3/4 inches thick.

8. Attachment to Precast Concrete Tee Construction:
   a) New Construction:
      (1) Use tee hanger inserts between adjacent flanges.
      (2) Use thru-bolts and fish plates, except at roof deck without concrete fill.

   b) Existing Construction:
      (1) Use anchoring devices installed in webs of tees. Install anchoring devices as high as possible in the webs.

   c) Do not use powder driven fasteners.

   d) Exercise extreme care in drilling holes to avoid damage to reinforcement.

9. Attachment to Wood Construction: Use side beam brackets fastened to the sides of wood members to make attachments for hangers.
   a) Under 15 lbs. Load: Attach side beam brackets to wood members with 2 No. 18 x 1-1/2-inch-long wood screws, or 2 No. 16 x 1-1/2-inch-long drive screws.

   b) Over 15 lbs. Load: Attach side beam brackets to wood members with bolts and nuts or lag bolts. Do not use lag bolts in wooden members having a nominal thickness (beam face) under 2 inches in size. Install bolts and nuts or lag bolts in the side of wood members at the mid-point or slightly above. Install plain washers under all nuts.

LOAD	LAG BOLT SIZE	BOLT DIA.
15 lbs. to 30 lbs.	3/8 x 1-3/4 inches	3/8 inch
31 lbs. to 50 lbs.	1/2 x 2 inches	1/2 inch
Over 50 lbs. to load limit of structure.	Use bolt & nut	5/8 inch

      (1) Bottom chord of wood trusses may be utilized as structural support, but method of attachment must be specifically approved.
      (2) Do not make attachments to the diagonal or vertical members of wood trusses.
      (3) Do not make attachments to the nailing strips on top of steel beams.

10. Attachment to Metal Stud Construction: Use supporting fasteners manufactured specifically for the attachment of raceways and boxes to metal stud construction.
   a) Support and attach outlet boxes so that they cannot torque/twist. Either:
      (1) Use bar hanger assembly, or:
      (2) In addition to attachment to the stud, also provide far side box support.

3.04 CONDUIT SUPPORT SCHEDULE

A. Provide number of supports as required by National Electrical Code. Exception: Maximum support spacing allowed is 4'-0" for conduit sizes 3 inches and larger supported from wood trusses.

B. Use pipe straps and specified method of attachment where conduit is installed proximate to surface of wood or masonry construction.

1. Use hangers secured to surface with specified method of attachment where conduit is suspended from the surface.

C. Use "C" beam clamps and hangers where conduit is supported from steel beams.

D. Use deck clamps and hangers where conduit is supported from steel decking having hanger tabs.

1. Where conduit is supported from steel decking which does not have hanger tabs, use clamps and hangers secured to decking, utilizing specified method of attachment.

E. Use channel support system supported from structural steel for multiple parallel conduit runs.

F. Where conduits are installed above ceiling, do not rest conduit directly on runner bars, T-Bars, etc.

1. Conduit Sizes 2-1/2 Inches and Smaller: Support conduit from ceiling supports or from construction above ceiling.

2. Conduit Sizes Over 2-1/2 Inches: Support conduit from beams, joists, or trusses above ceiling.

3.05 LIGHTING FIXTURE SUPPORT SCHEDULE

A. General: Do not support fixtures from ceilings or ceiling supports unless it is specified or indicated on the drawings to do so.

1. Support fixtures with hanger rods attached to beams, joists, or trusses. Hanger rod diameter, largest standard size that will fit in mounting holes of fixture.
   a) Where approved, channel supports may span and rest upon the lower chord of trusses and be utilized for the support of lighting fixtures.

   b) Where approved, channel supports may span and be attached to the underside of beams, joists, or trusses and be utilized for the support of lighting fixtures.

2. Use 2 nuts and 2 washers on lower end of each hanger rod to hold and adjust fixture (one nut and washer above top of fixture housing, one nut and washer below top of fixture housing).
   a) Where specified that an adequately supported outlet, box is to support a fixture or be utilized as one point of support, support the box so that it may be adjusted to bring the face of the outlet box even with surface of ceiling.

B. Number of Supports for Ceiling Mounted Lighting Fixtures: Provide at least the following number of supports. Provide additional supports when recommended by fixture manufacturer or shown on the drawings.

1. Commercial and Industrial Fixtures:
   a) Support individual fixtures less than 2 feet wide at 2 points.

   b) Support continuous row fixtures less than 2 feet wide at points equal to the number of fixtures plus one. Uniformly distribute the points of support over the row of fixtures.

c) Support individual fixture 2 feet or wider at 4 corners.

d) Support continuous row of fixtures 2 feet or wider at points equal to twice the number of fixtures plus 2. Uniformly distribute the points of support over the row of fixtures.

e) An adequately supported outlet box may be utilized as one point of support for fixtures weighing less than 50 pounds.

C. Number of Supports for Wall Mounted Lighting Fixtures: Provide at least the following number of supports. Provide additional supports when recommended by fixture manufacturer or shown on the drawings.

1. Commercial and Industrial Fixtures:
   a) Support individual fixtures 2 feet long or less at 2 points.

   b) Support individual fixtures over 2 feet long at 3 points.

   c) Support continuous row fluorescent fixtures at points equal to twice the number of fixtures. Uniformly distribute the points of support.

   d) An adequately supported outlet box may be utilized as one point of support for fixtures weighing less than 50 pounds.

2. Vandal Resistant, Fixtures:
   a) Support individual fluorescent fixtures 2 feet long or less at 4 points (each corner).

   b) Support individual fluorescent fixtures over 2 feet long at 6 points (each corner and midway along each side of longest axis).

   c) Support continuous row fluorescent fixtures at points equal to 6 times the number of fixtures. Uniformly distribute the points of support.

   d) An adequately supported outlet box may be utilized as one point of support for fixtures weighing less than 50 pounds.

3.06 CHANNEL SUPPORT SYSTEM SCHEDULE

A. Use channel support system where specified or indicated on the drawings.

B. Channel supports may be used, as approved, to accommodate mounting of equipment.

C. Material and Finish:

1. Dry Locations: Use 12 gage steel channel support system having any one of the specified finishes.

2. Damp Locations: Use 12 gage steel channel support system having any one of the specified finishes except green epoxy/enamel.

3. Wet Locations: Use 12 gage steel channel support system having hot dipped galvanized, or PVC finish.

END OF SECTION

SECTION 260195 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract including the General and Supplementary Conditions of Division 1 of the Specification Sections, apply to the work of this section.

1.02 SECTION INCLUDES

A. Nameplates and labels.
B. Wire and cable markers.
C. Conduit markers.

1.03 REFERENCES

A. Refer to Division 1.
B. NFPA 70 - National Electrical Code.

1.04 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.01 NAMEPLATES AND LABELS

A. Nameplates: Engraved three-layer laminated plastic, black letters on white background

1. Locations:
   a) Outside of each electrical panel. Indicate panel name.
   b) Control equipment enclosure. Indicate equipment name and branch circuit.
   c) Disconnects Indicate equipment name and branch circuit.
   d) Distribution panel breakers. Indicate load served.

2. Letter Size:1/8-inch letters.

B. Labels: Circuit designation shall be indicated with clear adhesive tape, 3/16-inch black letters on clear background. Use only for identification of individual wall switches and receptacles and control device stations. Tape label shall be adhered to the faceplate of each device.

C. Provide flash protection label per NEC 110.16 for equipment furnished under this Contract including switchboards, panelboards, industrial control panels and motor control centers. Seton #M0547; or equal.

2.02 WIRE MARKERS

A. Description: Tape type wire markers.

B. Locations: Each conductor at panelboard gutters and each load connection.

C. Legend: Branch circuit or feeder number indicated.

2.03 PANEL SCHEDULES

A. Provide complete type written directory for each panelboard listing room number, function, etc., for each circuit breaker.

B. Provide type written updated panelboard directories for existing panelboards affected by this work.

C. Panel directory must also include the up stream panel that services the panel. (i.e. "Fed from MDP Circuits 2,4,6"). Refer to details for additional information.

D. Include a Microsoft word or excel file with all panel schedules as part of the close out submittals.

2.04 DEVICES

A. Provide a tape label on all receptacle and switch coverplates, power poles, etc. listing panel designation and circuit number. Tape shall be attached to outside of receptacle or switch coverplates.

B. In permanent marker write the panel and circuit number on the wall behind receptacle cover plate or inside receptacle back box.

2.05 JUNCTION AND PULL BOXES

A. Identify junction and pullboxes for particular service such as power, lighting, fire alarm, telephone, intercom, public address, nurse call, etc. using stencil lettering on cover.

2.06 CONDUIT

A. Provide adhesive marking labels for raceway and metal-clad cable. The labels shall indicate voltage and service and be located above ceilings every 75 feet and on wall mounted conduit in mechanical and equipment rooms.

PART 3 - EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive nameplates and labels.

3.02 INSTALLATION

A. Install nameplate and label parallel to equipment lines.

B. Secure nameplate to equipment front using adhesive.

C. Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.

END OF SECTION

SECTION 260519 - WIRE AND CABLE (600 V AND BELOW)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract including the General and Supplementary Conditions of Division 1 of the Specification Sections, apply to the work of this section.

1.02 WORK INCLUDED

A. Conductors.
B. MC Cable.
C. Terminations.

1.03 SUBMITTALS

A. Schedule of all wiring and cable usage.
B. Product data sheets for all wire and cable types.

PART 2 - PRODUCTS

2.01 CONDUCTORS

A. Feeder, branch circuit and control wiring:

1. Annealed Copper, 98% conductivity.
2. Minimum wire size:
   a) #12 AWG for branch circuits
   b) #14 AWG for control and signal circuits
3. #8 AWG Wire and above shall be stranded.
4. 600-volt insulation for all wiring above 50 volts.
5. 300-volt insulation permitted for all wiring below 50 volts.
6. Thermal plastic with PVC insulation with nylon jacket, suitable for wet or dry locations, THHN/THWN 90 degree Celsius.
7. 90-degree C maximum operating temperature rating.
8. UL 83 Listed

B. Lighting fixture wire

1. FREP/CPE coated stranded copper,
2. Flame retardant EPR Insulation and CPE jacket.
3. UL 44 listed

C. Flexible cords and cables shall be Type "SO" or "SJO.

D. Color Coding:

1. All circuits shall be color coded according to the following schedule:

Voltage	A PHASE	B PHASE	C PHASE	NEUTRAL
208Y/120V, 3 Phase	Black	Red	Blue	White

*ALL GROUNDING CONDUCTORS SHALL BE GREEN

2. #6 AWG and smaller shall have insulation continuously colored as called for above.
3. #4 AWG and larger may by identified using a minimum 3" tape band.
4. Color code all conductors at all pullboxes, enclosures, and terminations.

5. Switched legs shall be identified with the same color insulation as the phase leg.

E. Acceptable manufacturers:

1. Cablec
2. Southwire
3. Okonite
4. Rome Cable
5. Pirelli

2.02 TYPE MC METAL CLAD CABLE

A. Construction:

1. Stranded or solid copper conductors, each individually insulated, and enclosed in an armor of flexible metal tape.

2. Suitable for wet or dry locations.

3. Suitable for cable tray installations.

4. Do not install direct buried, in concrete, or in the presence of corrosive vapors.

5. Provide with separate integral grounding conductor.

6. Support every 6 feet.

7. Manufactured and installed in accordance with NEC Article 330

8. Make: Acceptable manufacturers:
   a) AFC
   b) Southwire
   c) United Copper Industries

2.03 METAL CLAD COMBINATION LIGHTING POWER AND CONTROL CABLE.

A. Cable Shall have following construction

1. Armor: Galvanized Interlocking Steel Strip (blue armor) or Interlocking Aluminum Strip

2. Solid or Stranded Copper Conductors

3. Insulated Conductor Type THHN

4. Neutral Conductor: White or Gray

5. Control Cables: 16 AWG Solid TFN Twisted jacketed pair (Purple/Gray)

6. Insulation Permitting conductors of control circuits to be placed in a cable with conductors of electric light, power, or Class 1 circuits

B. Standards

1. UL 66, 83, 1479, 1569, 1581, 2556, File Reference E80042

2. NEC 250.118, 300.22(C), 392, 396, 330, 501, 502,503, 530, 504, 505, 518, 520, 530, 645, 725

3. Federal Specification A-A-59544 (formerly J-C-30B)

4. Meets all applicable OSHA and HUD Requirements

5. Cable Tray Rated

6. UL Classified 1, 2, and 3 hour through penetration (Fire Stop) product, R 14141

7. Environmental Air-Handling Space Installation per NEC 300.22(C)

8. Power and/or lighting as well as signal and/or control conductors per NEC Section 725.136(I)(1)

C. Design Make: AFC MC Tuff Luminary Cable

2.04 LOW VOLTAGE CONNECTORS AND TERMINATIONS

A. Straight Splices, #26 AWG to #10 AWG:

1. Nylon Insulated compression butt-splices.
2. 600-volt, 90-degree C rated.
3. Make: Burndy "Insulink", T&B "Sta-Kon", or approved equal

B. Straight Splices, #8 AWG and Larger:

1. Two-way, long barrel, compression type, copper
2. Provide heat shrink tubing over splice.
3. 600 volt rated.
4. Make: Burndy "Hylink", T&N 54800 Series, or approved equal.

C. Pigtail Splices, #26 AWG to #10 AWG:

1. Twist type pressure connector.
2. 600 volt rated, 105 degree C.
3. Size as required for number and size of conductors used.
4. Make: T&B Scotchlock, or approved equal

D. Three Way Splices, #8 AWG and Larger:

1. Three-way, long barrel, compression type, copper.
2. Provide tape or heat shrink tubing over splice.
3. 600 volt rated.
4. Make: Burndy "Hylink", T&B 54700 Series, or approved equal.

E. Lug Terminations for Control and Signal Wiring:

1. Nylon insulated fork with compression termination of #26 AWG to #10 AWG.
2. Nylon insulated ring with compression termination for #8 AWG and larger.
3. 300 volt rated.
4. Make: Burndy "Insulug", T&B "Sta-Kon", or approved equal.

F. Lug Terminations for Power Wiring:

1. Long barrel, compression type, copper body, on hole for #8 AWG to #2/0 AWG.
2. Long barrel, compression type, copper body, two hole, for #3/0 AWG and larger.
3. 600 volt rated.
4. Make:
   a) One-hole lug: Burndy "Hylug", T&B 54900 Series, or approved equal.

b) Two-hole lug: Burndy "Hylug", T&B 54800 Series, or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Route wire and cable as required to meet Project Conditions.

B. Install cable in accordance with the NECA "Standard of Installation."

C. Use stranded conductors for control circuits.

D. Use conductor not smaller than 12 AWG for power and lighting circuits.

E. Use conductor not smaller than 16 AWG for control circuits.

F. Use 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 100 feet.

G. Identify and color code wire and cable under provisions of this section. Identify each conductor with its circuit number or other designation indicated.

H. Install cables in raceway as called for after the entire raceway system has been completed.

I. Install splices and connections in accessible outlet, pull, and junction boxes.

J. Insulate all splices and connections with UL Labeled plastic tape, heat shrink tubing, or plastic molded caps.

K. All wiring systems shall be properly grounded and continuously polarized throughout, following the color coding specified.

L. Provide a green equipment ground with all feeders and all branch circuits' size per the NEC.

M. Provide dedicated white insulated neutral conductor for each branch circuit. Shared neutrals are not allowed.

N. Install a maximum of three phase conductors, three neutral conductors, and one grounding conductor in each home run. (Obtain approval for additional conductor fill where field conditions require. Adhere to NEC de-rating requirements.)

O. Provide stranded wire to motors, transformers, equipment, and vibrating machinery.

P. Feeder conductors shall be continuous from point of origin to load termination without splice. If this is not practical, contact the Owner's Representative and receive written approval for splicing prior to installation of feeder(s). Where feeder conductors pass through junction and pull boxes, bind and lace conductors of each feeder together. For parallel sets of conductors, match lengths of conductors.

Q. Use pulling means including fish tape, cable, and rope and basket type grips which will not damage cables or raceways. Use approved mechanical pullers for feeders and branch circuits as required for #6 AWG cable and larger. Do not use mechanical means to pull conductors No. 8 or smaller.

R. Branch circuit conductors installed in panelboards, and control conductors installed in control cabinets and panels shall be neatly bound together using "Ty-Raps" or equivalent.

S. Reconnect branch circuit wiring at panelboards as required to obtain a balanced three phase load on the feeders.

T. Properly splice and neatly coil extraneous wires in outlet boxes.

U. Wiring in panelboards and equipment enclosures etc. shall be neatly trained and arranged so as not to preclude access to the space or equipment contained therein. Provide all additional cable supports and ties required to comply.

V. The system shall be properly grounded and continuously polarized throughout, following the color coding specified.

W. Wiring within panelboards, control cabinets, pull boxes, wiring troughs and annunciator and/or alarm panels shall be neatly bundled together with ties not requiring tools to install. Two, three and four wire circuits emerging from the bundle shall be trained and tied individually.

X. Where multiple conductors are installed in a common raceway they shall be pulled simultaneously. Use of pulling compound or lubricant shall be avoided unless absolutely necessary. Where pulling lubricant is required, use UL approved compounds approved for cable type. Lubricant shall meet all OSHA and Toxic Control Act standards.

APPLICATION	CABLE TYPES	DESIGN MAKE
General purpose Construction & Maintenance	Rubber, Neoprene, Nylon, PVC, High Density XLP, Hypalon	Ideal - Yellow 77
High Temperature Construction & Maintenance	Rubber, Neoprene, Nylon, PVC, High Density XLP, Hypalon, Low Density Polyethylene, Semiconducting Jacket	Ideal - Yellow 190
Utility construction & Maintenance	Rubber, Neoprene, Nylon, PVC, High Density XLP, Hypalon, Low Density Polyethylene, Semiconducting Jacket	Aqua-Gell II
Cold Weather Construction & Maintenance	Rubber, Neoprene, Nylon PVC, High Density XLP, Hypalon, Low Density Polyethylene, Semiconducting Jacket	Aqua-Gel CW

3.02 CIRCUITING

A. The following takes precedence over the drawings:

1. General purpose receptacle and lighting branch circuits may be combined in single conduits in accordance with NEC requirements and restrictions.

2. Conductors serving individual pieces of equipment or grouped equipment or isolated ground branch circuits shall not be combined.

3. Provide dedicated Neutrals.

3.03 SPLICES

A. Dry locations: For conductors #10 AWG and smaller use standard spring type pressure connectors or compression type connectors with insulating jackets.

B. For conductors #8 AWG and larger use compression type connectors and insulate in accordance with manufacturer's recommendations.

C. Damp locations: Use same type splices as indicated for dry locations and wrap with moisture sealing tape.

D. Wire runs shall be continuous. All splicing shall be done only in accessible boxes.

3.04 LOW VOLTAGE CONTROL WIRING

A. Low voltage control wiring shall not be run in same conduit system as power feeds. All low voltage control wiring in equipment shall be neatly bundled, identified and installed remote from any and all mechanical moving parts. All low voltage control wiring in walls shall be installed in conduit, the same as required for power wiring. All low voltage wiring above inaccessible ceilings shall be installed in conduit. All low voltage wiring exposed in finished spaces shall be installed in wiremold surface raceway. All low voltage wiring exposed in unfinished spaces shall be installed in conduit. All low voltage control wiring above accessible ceilings shall be bundled, neatly run at right angles and/or parallel to building steel, tied to steel as high as possible with no more than 3" sags; wire may not be laid on ceiling framing or supported by ceiling framing. Low voltage wiring shall not be run between decking flutes or above structural members.

3.05 TYPE MC METAL CLAD CABLE

A. MC Cable shall be permitted for up to 6' fixture whips from junction boxes above drop ceiling areas to recessed light fixtures.

B. MC Cable shall be permissible for up to 10 ft drop from junction box to outlets in walls. MC Cable shall be permitted for horizontal cabling in drywall partitions.

C. Type MC Cable shall not be used for feeders or branch circuit home runs to panelboards.

D. Support cable at intervals not exceeding 4 feet.

E. Bending radius shall comply with Article 330.24 of the NEC.

F. Provide insulating bushing at all termination points between the metal sheath and outlet or junction box.

G. Type MC Cable shall not be installed exposed with the exception of fixture drops in mechanical or equipment rooms. Secure the cable to fixture hangers using nylon or plastic ties.

END OF SECTION

SECTION 260526 - GROUNDING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract including the General and Supplementary Conditions of Division 1 of the Specification Sections, apply to the work of this section.

1.02 SECTION INCLUDES

A. Grounding and bonding conductor materials.

B. Equipment grounding and bonding requirements.

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. B3: Soft or Annealed Copper Wire.
2. B8: Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard, or Soft.
3. B33: Tinned Soft or Annealed Copper Wire for Electrical Purposes.

B. Institute of Electrical and Electronic Engineers (IEEE):

1. 81: Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
2. 1100: Powering and grounding sensitive electronic equipment.

C. International Electrical Testing Association (NETA).

D. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC).
2. 780: Lightning Protection Code.

E. Occupational Safety and Health Administration (OSHA):

1. 29CFR 1910.7 Definitions and requirements for Nationally Recognized Testing Laboratories (NRTL).

F. Underwriters Laboratories (UL):

1. 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.
2. 467: Grounding and Bonding Equipment.

1.04 QUALITY ASSURANCE

A. Testing Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7, or a full member company of NETA.

1. Testing Agency Field Supervision: Use persons currently certified by NETA or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in PART 3.

B. Comply with NFPA 70, National Electrical Code.

C. Comply with UL 467.

D. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

2. Listing and Labeling Agency Qualifications: A NRTL as defined in OSHA Regulation 1910.7.

1.05 SUBMITTALS

A. Product Data for grounding wiring, grounding rods, connectors and connection materials, ground busses or plates, identification materials and grounding fittings.

B. Qualification data for firms and persons specified in "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.

C. Field tests and observation reports certified by the testing organization and indicating and interpreting the test reports for compliance with performance requirements.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Kearney/Cooper Power Systems.
2. Lyncole XIT Grounding.
3. Salisbury: W. H. Salisbury & Co.
4. Thomas & Betts, Electrical.
5. Chance/Hubbell.
6. O-Z/Gedney Co.; a business of the EGS Electrical Group.

2.02 WIRE AND CABLE GROUNDING CONDUCTORS

A. Conform to NEC Table 8, except as otherwise indicated, for conductor properties, including stranding. The requirements below apply for new cables installed as well as for upgrading of identification of existing cables as indicated on drawings.

1. Material: Copper. Use only copper wire for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

B. Equipment Grounding Conductors: Insulated with green color insulation.

C. Underground Conductors: Bare, tinned, stranded, except as otherwise indicated.

D. Bare Copper Conductors: Conform to the following:

1. Solid Conductors: ASTM B3.
2. Assembly of Stranded Conductors: ASTM B8.
3. Tinned Conductors: ASTM B33.

E. Color coding of ground cables - Where new or existing cables are concealed and not color-coded, any exposed portion of the cable and each end of the cable for a minimum of 2 feet shall be color coded by green tape overlaid with bright tracer color tape to form the tracer. Where routed through raceways, wire ways, cable trays or under raised floors, the color-coding shall be such that by removing or opening any cover, color-coding shall be visible. Where conductors are routed through cable trays, color-coding for a minimum length of 4 inches shall be accomplished at intervals not exceeding three feet between marking.

2.03 MISCELLANEOUS CONDUCTORS

A. Grounding Plates:

1. Bare or tinned, annealed-copper. Size as per specifications or larger as indicated on drawings.

B. Braided Bonding Jumpers: Where electrical continuity across shock mounts is necessary, bonding jumpers shall be installed across each shock mount. Jumpers of this application should have a maximum thickness of 0.025 inch, so that the damping efficiency of the mount is not impaired. In severe shock and vibration environments, solid straps may be corrugated, or flexible tinned copper wire braid may be used. Braids are to be terminated with tinned copper ferrules.

C. Raceway Bonding Jumpers: Copper, minimum size #6 AWG unless otherwise noted.

2.04 CONNECTOR PRODUCTS

A. Exothermic-Welded Connections: Provided in kit form and selected per manufacturer's written instructions for specific types, sizes, and combinations of conductors and connected items.

PART 3 – EXECUTION

3.01 GENERAL

A. A separate ground conductor (green wire) shall be installed in all raceways for feeders, power and receptacle branch circuits and where called for on drawings.

B. Switchboards shall have a separate ground bus bonding all cubicles together.

C. All distribution and branch circuit panels shall have a separate ground bar

D. All metallic conduits 1-1/4" or larger shall have grounding bushings.

E. All type SO cord, or equivalent, shall have a separate ground wire (green) of equal size to circuit conductor.

F. Equipment ground conductor shall be copper with Type THHN insulation, green only, up to and including #4; larger sizes may be bare conductor, or black and identified with green tape.

G. Paint, grease or other contaminates shall be cleaned from all surfaces before bonding ground conductor. (Painted surfaces shall be sanded and cleaned.)

H. Equipment Grounding Conductors: All metallic non-current carrying parts of electrical equipment shall be grounded with equipment grounding conductors whether or not shown on the drawings. Equipment grounding conductors shall be green insulated copper conductors unless otherwise indicated.

1. Install green, equipment grounding conductor with all feeder and branch circuit conductors.

I. Signal and Communication Systems: For telephone, fire alarm, security, voice, and data systems in the equipment room, provide a #4/0 AWG minimum insulated grounding conductor in raceway from grounding-electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

J. Service Locations and Wiring Closets: Terminate grounding conductor on a multipoint ground plate.

K. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

L. Enclosures: Ground all enclosures of electrical and electronic wiring and distribution equipment in accordance with requirements of the NEC.

M. Conduit or cable shields shall not be used as the equipment grounding conductor.

N. Equipment Enclosure Grounding: Bare wire, wrapped around connecting screws or mounting bolts and screws is not acceptable as a grounding connection. All ground lugs shall be of a noncorrosive material suitable for use as a grounding connection and must be compatible with the type of metal being grounded. Ground lugs shall be mounted on clean, bare metal surfaces that are free of paint, rust, etc. Wire brush clean each surface to remove paint or oxidation prior to bolting jumper connectors in place. In general use tinned copper connectors for connections of dissimilar metals. Use of bimetal connectors shall only be allowed in special circumstances and only with the prior written approval

3.02 CONNECTIONS

A. General: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to assure 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. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Use for connections to structural steel, for underground connections, and were indicated on drawings. Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable and will be redone at the contractor's expense. Utilize 'smokeless' type weld kits for all exothermic welds performed in interior of structure

C. Terminate insulated equipment grounding conductors for feeders with pressure-type grounding lugs. Where metallic raceways terminate at non-metallic or non-conductive housings, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to the ground bus in the housing. Bond electrically non-continuous conduits at both entrances and exits with grounding bushings and bare grounding conductors.

D. Raceway Grounding: Surface metal raceways, wireways, or cable trays or cable rack systems shall be installed in a manner that ensures electrical continuity. Short insulated green copper bonding jumpers shall be installed between adjacent raceway sections, on both sides of each joint, to ensure proper bonding. Unless otherwise indicated, the minimum size for these bonding jumpers shall be No. 6 AWG. Jumpers shall be provided with compression connectors at each end of cable. Surface metal raceways, wireways, cable trays or cable rack systems shall be field drilled to provide bolting point for securing bonding jumper. Wire brush clean each surface to remove paint or oxidation prior to bolting jumper connectors in place. Bolts and hardware shall be as per details or as approved for grounding purposes. All metallic raceway penetrations into a facility structure shall be bonded to the earth electrode system.

E. Other Grounding Systems: Any additional grounding systems used for electronic equipment shall be connected to the facility main ground plate, structural steel or exterior earth electrode system as shown on drawings.

F. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with torque tightening values specified in UL 486A.

G. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Mechanical connections using a Burndy "Hyground Connector", Thomas and Betts Compression Connector or equivalent equipment when operated at the manufacturers recommended pressure to develop a minimum force of 12 tons is acceptable as approved pressure connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on ground conductor. Hydraulically crimped connectors are not acceptable in the lightning protection system.

3.03 RACEWAY SYSTEMS

A. All metal supports, cable trays, frames, sleeves, brackets, braces, etc. for the raceway system, panelboards, switchboards, switches, enclosures, starters, controls, etc., which are not rigidly secured to and in contact with the raceway system, or which are subject to vibration and loosening, shall be bonded to the raceway system. Size the bonding conductor in accordance with NEC Article 250, Table 250-122.

B. Terminate rigid conduit at all boxes, cabinets, and enclosures tightly with two locknuts and a bushing.

C. Conduit which runs to or from all boxes, cabinets, or enclosures having concentric or eccentric knockouts which partially perforate the metal around the conduit and hence impair the continuity of system ground circuits shall be provided with bonding jumpers sized in accordance with NEC Article 250, Table 250-122. Connect the bonding jumper between a grounding type bushing on the conduit and a ground bus or stud inside the box, cabinet, or enclosure.

D. Provide bonding jumpers sized in accordance with NEC Article 250, Table 250-122 for all conduit expansion joints.

E. Provide a grounding conductor in all flexible metallic conduit and liquid-tight conduit, sized in accordance with NEC Article 250, Table 250-122.

F. Provide a grounding conductor in all nonmetallic runs of conduit and raceway, sized in accordance with NEC Article 250, Table 250-122.

G. Provide isolated ground conductors of systems as called for on the plans.

H. Provide bonding bushings and connections in all of the following:

1. Service equipment enclosures.
2. Openings with eccentric or concentric knockouts.
3. Openings using reducing washers.
4. Hazardous locations.
5. Greater than 250V to ground systems.

3.04 SECONDARY ELECTRICAL SYSTEMS

A. Solidly ground all transformer neutral conductors and enclosures to building steel, or a cold water pipe 1" or larger in size as called for in Table 250-122 of the National Electrical Code.

B. Provide an equipment grounding conductor from the point of termination back to the ground bus of the serving panelboard, switchboard, or transformer. Do not splice equipment grounding conductors.

C. Provide an equipment grounding conductors from the point of termination back to the ground bus of the serving panelboard, switchboard, transformer, or switchgear.

D. The grounding conductors contained in the interstices of interlocked armor cable shall be connected to the ground bus at every equipment termination point and to each other and to system ground; ground at every splice location.

3.05 TESTS

A. Grounds and grounding systems shall have a resistance to solid earth ground not exceeding following values:

1. For grounding of 5 KV equipment, enclosures, and cable shields: 10 Ohms.

2. For grounding secondary service neutral: 25 Ohms.

3. For grounding non-current carrying metal parts associated with secondary distribution system: 25 Ohms.

B. Providing grounding tests to verify the above values. Where these values are not met, add additional ground rods or connections in order to meet these values.

END OF SECTION

SECTION 260533 - CONDUIT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract including the General and Supplementary Conditions of Division 1 of the Specification Sections, apply to the work of this section.

1.02 WORK INCLUDED

A. Metal conduit.
B. Liquid tight flexible metal conduit.
C. Electrical metallic tubing.
D. Flexible metal conduit.
E. Fittings and conduit bodies.

1.03 SUBMITTALS

A. Submit for approval a list of each product and the manufacturer.

1.04 REFERENCES

A. ANSI-C80.2, 1983: Specification for Rigid Steel Conduit, Enameled.

B. ANSI C80.3: Electrical Metallic Tubing, Zinc Coated.

C. ANSI/NEMA FB 1: Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.

D. NECA "Standard of Installation."

E. NEMA TC 2: Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).

F. NEMA TC 3: PVC Fittings for Use with Rigid PVC Conduit and Tubing.

G. NEMA, RN1, 1986: PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.

H. NEMA, TC 6, 1983: PVC and ABS Plastic Utilities Duct for Underground Installations.

I. NEMA, TC 8, 1983: Extra strength PVC Plastic Utilities Duct for Underground Installations.

J. NEMA, TC 9, 1983: Fittings for ABS and PVC Plastic Utilities Duct and Fittings for Underground Installation.

K. NEMA, TC 10, 1983: PVC and ABS Plastic Communications Duct and Fittings for Underground Installation.

L. The following U.L. Standards:

1. UL 1, 1985: Flexible Metal Electrical Conduit.
2. UL 3, 1984: Flexible Nonmetallic Tubing for Electric Wiring.
3. UL 6, 1981: Rigid Metal Electrical Conduit.
4. UL 360, 1986: Liquidtight Flexible Steel Conduit, Electrical.
5. UL 514B, 1982: Fittings for Conduit and Outlet Boxes.
6. UL 651, 1981: Schedule 40 and 80 PVC Conduit.
7. UL 797, 1983: Electrical Metallic Tubing.

8. UL 870, 1985: Electrical Wireways, Auxiliary Gutters and Associated Fittings.

PART 2 - PRODUCTS

2.01 CONDUIT REQUIREMENTS

A. Minimum Size: 3/4" unless otherwise specified.

B. Underground Installations:

1. Use thickwall non-metallic conduit.
2. Under Slab on Grade: Use thickwall non-metallic conduit.
3. Minimum Size: 1".

C. Outdoor Locations, Above Grade: Use rigid steel conduit.

D. In Slabs Above Grade:

1. Use rigid steel conduit or intermediate metal conduit.

E. Indoor:

1. Concealed: Use electrical metallic tubing.
2. Exposed: Use EMT unless otherwise called for.

2.02 RIGID GALVANIZED STEEL CONDUIT

A. Steel, hot dipped galvanized on the outside and inside, UL categorized as Rigid Ferrous Metal Conduit (identified on UL Listing Mark as Rigid Metal Conduit - Steel or Rigid Steel Conduit).

B. Acceptable manufacturers:

1. LTV Steel
2. Triangle
3. Allied Tube
4. Steel Duct
5. Wheatland

2.03 ELECTRICAL METALLIC TUBING

A. Steel, galvanized on the outside and enameled on the inside, UL categorized as Electrical Metallic Tubing (identified on UL Listing Mark as Electrical Metallic Tubing).

B. Acceptable manufacturers:

1. Triangle
2. Wheatland
3. Allied Tube
4. Steel Duct
5. LTV Steel

2.04 FLEXIBLE METAL CONDUIT

A. Flexible Metal Conduit shall be constructed of one continuous length of spirally wound, interlocked, zinc coated strip steel. Interior surface shall be free from burrs or sharp edges. UL categorized as Flexible Metal Conduit (identified on UL Listing Mark as Flexible Steel Conduit or Flexible Steel Conduit Type RW).

B. Acceptable manufacturers:

1. Anaconda
2. American Flexible Conduit Co.
3. O-Z/Gedney
4. Thomas and Betts

2.05 LIQUID TIGHT FLEXIBLE METAL CONDUIT

A. Flexible Metal Conduit shall be constructed of one continuous length of spirally wound, interlocking zinc coated strip steel. Interior surfaces shall be free from burrs and sharp edges. Provide with a liquid-tight jacket of flexible polyvinyl chloride (PVC). UL categorized as liquid-tight flexible metal conduit (identified on UL Listing Mark as Liquid-Tight Flexible Metal Conduit, also specifically marked with temperature and environment application data).

B. Acceptable manufacturers:

1. Allied
2. American Flexible Conduit
3. Carlon
4. Thomas and Betts

2.06 FITTINGS AND ACCESSORIES

A. Rigid galvanized steel fittings shall be fully threaded and shall be of the same material as the respective raceway system.

B. Fittings for electrical metallic tubing shall be single screw indenter fittings for conduits up to 2" and double screw indenter fittings for conduits 2" and larger.

C. Fittings for flexible metal conduit shall be center stopped, insulated throat, U.L. E-11852 listed.

D. Fittings for liquidtight flexible metal conduit shall have zinc plated steel ferrule, compression type with sealing ring.

E. Fittings for rigid non-metallic conduit shall be solvent cemented in accordance with the manufacturer's instructions.

F. Fittings for PVC coated rigid galvanized steel conduit shall be threaded, hot dipped galvanized, and coated inside and outside with a urethane coating.

G. Connectors shall have insulated throat up to and including 1" size. For sizes 1-1/4" and larger, provide plastic insulating bushing.

H. Die-cast or pressure cast fittings are not permitted.

I. Provide conduit bodies' types, shapes and sizes as required to suit application and NEC requirements. Provide matching gasketed covers secured with corrosion-resistant screws.

J. Insulated Bushings:

1. Threaded, malleable iron/zinc electroplate with 105 degrees C minimum plastic insulated throat; Appleton Electric Co.'s BU50I Series, Cooper/Crouse-Hinds' 1031 Series, OZ/Gedney Co.'s IBC-50 Series, Raco Inc.'s 1132 Series, Steel City/T & B Corp.'s BI-901 Series, or Thomas & Betts Corp.'s 1222 Series.

2. Threaded malleable iron with 150 degrees C plastic throat; Appleton Electric Co.'s BU501 Series, Cooper/Crouse-Hinds' H1031 Series, or OZ/Gedney Co.'s IBC-50 Series.

K. Plastic Bushings for 1/2 and 3/4 Inch Conduit:

1. 105 degrees C minimum temperature rating; Appleton Electric Co.'s BBU50, BBU75, Blackburn (T & B Corp.'s) 50 BB, 75 BB, Cooper/Crouse-Hinds' 931,932, or OZ/Gedney Co.'s IB-50, IB-75, Raco Inc.'s 1402, 1403, Steel City/T & B Corp.'s BU-501, BU-502, or Thomas & Betts Corp.'s 222, 223.

2. 150 degrees C temperature rating; Appleton Electric Co.'s BBU50H, BBU75H, Cooper/Crouse-Hinds' H-931, H-932, or OZ/Gedney Co.'s A-50, A-75.

L. Insulated Grounding Bushings:

1. Threaded, malleable iron/zinc electroplate with 105 degrees C minimum plastic insulated liner, and ground lug; Appleton Electric Co.'s GIB-50 Series, Cooper/Crouse-Hinds' GLL Series, OZ/Gedney Co.'s IBC-50L Series, Raco Inc.'s 1212 Series, Steel City/T & B Corp.'s BG-801 (1/2 to 2") Series, or Thomas & Betts Corp.'s 3870.

2. Threaded malleable iron/zinc electroplate with 150 degrees C plastic insulated liner, and ground lug; Appleton Electric Co.'s GIB Series, Cooper/Crouse-Hinds' HGLL Series, or OZ/Gedney Co.'s IBC-50L Series, or Thomas & Betts Corp.'s 3870.

M. Sealant for Raceways Exposed to Different Temperatures: Sealing compounds and accessories to suit installation; Appleton Electric Co.'s DUC, or Kwiko Sealing Compound with fiber filler, Cooper/Crouse-Hinds' Chico A Sealing Compound with Chico X fiber, Electrical Products Division 3M Scotch products, OZ Gedney Co.'s DUX or EYC sealing compound with EYF damming fiber, or Thomas & Betts Corp.'s Blackburn DX.

N. Vertical Conductor Supports: Kellems/Hubbell Inc.'s Conduit Riser Grips, or OZ/Gedney Co.'s Type M, Type R.

O. Pulling-In-Line for Installation in Spare and Empty Raceways: Polypropylene monofilament utility line; Greenlee Textron Inc.'s Poly Line 430, 431, or Ideal Industries Powr-Fish Pull-Line 31-340 Series.

P. Acceptable manufacturers:

1. O.Z. Gedney
2. Steel City
3. Thomas & Betts
4. Cooper Crouse-Hinds
5. Carlon
6. Raco

2.07 EXPANSION FITTINGS

A. Galvanized steel expansion joints for RGS or EMT conduit, PVC for PVC conduit. Minimum 4" movement in either direction.

B. Weatherproof for outdoor applications.

C. At expansion joints in concrete pours, provide Deflection/Expansion fittings capable of movement of 3/4" in all directions from the normal**.**

D. Design Make: O.Z./Gedney, Type "AX" (exposed), "DX" (Concrete Pour)

E. Acceptable manufacturers:

1. O.Z./Gedney
2. Crouse-Hinds
3. Appleton

2.08 EXPANDABLE CONDUIT PLUGS

A. Seal open underground telecommunications conduits entering the building with expandable conduit plugs with rope ties.

B. Refer to drawings for underground entrance locations.

C. Design Make: Osburn Associates or approved equal.

PART 3 - EXECUTION

3.01 GENERAL

A. Install conduit in accordance with NECA "Standard of Installation".

B. PVC conduit is not permitted in any interior location within a school.

C. All conduit penetrations through fire-rated construction must be sealed with UL listed fire stopping. Refer to architectural drawings for locations.

D. Size raceways as indicated on the drawings. Where sizes are not indicated, raceways shall be sized as required by the National Electrical Code in accordance with the quantity, size, type and insulation of conductors to be installed.

E. Minimum 1/2" trade size for branch circuit and fire alarm wiring.

F. Minimum 3/4" trade size for voice/data outlets, television outlets, and branch circuit "Home Runs" to panelboards.

G. Group related conduits; support using conduit rack. Construct rack using steel channel; provide space on each for 25% additional conduits.

H. Provide a code compliant ground path between all outlets and the established electrical system ground.

I. Coordinate all raceway runs with other trades.

J. Do not install raceways adjacent to hot surfaces or in wet areas. Maintain 12" clearance between conduit and surfaces with temperatures exceeding 104^{o} F (40^{o} C).

K. Provide expansion fittings with external grounding straps at building expansion joints.

L. Arrange neatly to permit access to the raceway, outlet, pull, and junction boxes, and work installed by other trades.

M. Use conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations.

N. All exposed conduit mounted to a painted surface shall be painted to match that surface.

O. No conduit shall be run in or through an Elevator Machine Room, hoistway or pit unless it contains circuitry specifically required for the elevator or elevator related equipment.

P. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.

Q. Provide at least one junction or pullbox for each 360 degrees of bends.

R. Provide green ground wire in all EMT, flexible conduit, and non-metallic conduit.

3.02 INSTALLATION

A. Install raceways parallel or perpendicular to building walls, floors and ceilings.

B. Cut raceways square, ream ends to remove burrs, and bush where necessary.

C. Route conduit in and under slab from point to point. Do not cross conduits in slab. Provide U.L. approved rain-tight and concrete tight couplings and connectors. All conduit in concrete floor slabs shall be rigid galvanized steel with concrete tight threaded fittings. Install conduit below the reinforcing mesh. Locate conduits to provide a minimum of 1" of concrete around conduit. Obtain approval from the Owner's Representative prior to installing conduit larger than 1" trade size in concrete slabs.

D. Install with a minimum of bends and offsets. Bends shall not kink or destroying the interior cross section of the raceway. Factory made bends shall be used for raceways 1" trade size and larger.

E. Support raceways from building construction. Do not support raceways from ductwork, piping, or equipment hangers. Arrange supports to prevent misalignment during wiring installation. Support conduit using coated steel or malleable iron straps, lay in adjustable hangers, clevis hangers, and split hangers. Do not attach conduit to ceiling support wires. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.

F. Plug the ends of each roughed-in raceway with an approved cap or disc to prevent the entrance of foreign materials during construction.

G. Secure conduit within three feet of each outlet box, junction box, cabinet or fitting.

H. Provide a #14 AWG fish wire in all "Spare" or "Empty" conduit runs to facilitate future installation of conductors.

I. Provide expansion fittings where conduits cross building expansion joints.

J. Wherever a cluster of (4) or more conduits rise out of floor exposed, provide neatly formed 4 in. high concrete envelope, with chamfered edges, around raceways.

K. Provide 4 spare 3/4-in. raceways from each flush mounted panelboard or cabinet to an area above the nearest accessible ceiling space. Make 90^{o} turn above the ceiling, arranged for further continuation of raceway, and cap.

L. Join non-metallic conduit using cement as recommended by manufacturer. Wipe non-metallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.

M. Where conduits puncture roof, install pitch pockets as required in order that the roof warranty is maintained.

N. If it is necessary to burn holes through webs of beams or girders, call such points to the attention of the Owner's Representative and receive written approval both as to location and size of hole before proceeding with work. All holes shall be burned no larger than absolutely necessary.

O. Core drill, sleeve, and fire stop all penetrations through existing floors.

P. In exterior or wet locations, provide minimum 1/4" air space between raceway and wall. Secure raceway within 3 ft. of each outlet box, junction box, cabinet or fitting.

Q. Provide conduit supports based on the following table:

Conduit Trade Size	Type of Run	Horizontal Spacing in Feet	Vertical Spacing in Feet
1/2", 3/4"	Concealed	7	10
1", 1-1/4"	Concealed	8	10
1-1/2" & larger	Concealed	10	10
1/2", 3/4"	Exposed	5	7
1", 1-1/4"	Exposed	7	8
1-1/2" & larger	Exposed	10	10

R. Conceal conduits in all locations except for mechanical and equipment rooms. Obtain owner's permission to run exposed conduits in other areas if existing conditions warrant exposed conduit.

3.03 REUSE OF EXISTING RACEWAYS

A. Number of Raceways: Do not change number of raceways to less than the number indicated on the drawings except when appropriate for advantageous reuse of existing exposed and concealed raceways (the contract documents do not indicate location, number, size or condition of existing raceways). Existing raceways may be reused if the following conditions are met:

B. The existing raceway must be of adequate size for the new conductors to be installed therein (NFPA 70 Chapter 9, Tables 1, 4, & 5; Appendix C, Tables C1-C12a). More circuits may be enclosed by existing raceways than the circuiting shown on the drawings provided conductor sizes are increased to compensate for derating (adjustment factors) and other considerations required by NFPA 70 Article 310-15.

C. Remove existing conductors.

D. Demonstrate to the Director's Representative that the existing raceway is clear of obstructions and in good condition.

E. Check ground continuity. When ground continuity of existing raceway is inadequate install insulated grounding bushings, grounding wedges, bonding straps, grounding jumpers or equipment grounding conductors to establish effective path to ground.

F. Install insulated bushings to replace damaged or missing bushings. Replace non-insulated bushings with insulated bushings on raceway sizes 1 inch and larger.

G. Install vertical conductor supports to replace existing or missing vertical conductor supports.

H. Install extension rings on existing boxes when the number of new conductors installed therein exceeds NFPA 70 requirements.

I. Furnish the Owners' Representative with marked up drawings showing size and routing of existing raceways with number and size of new conductors installed therein. The drawings will be forwarded to the design engineer for verification of NFPA 70 compliance.

3.04 RACEWAYS FOR FUTURE USE (SPARE RACEWAYS AND EMPTY RACEWAYS)

A. Draw fish tape through raceways in the presence of the Owners Representative to show that the raceway is clear of obstructions. Leave a pulling-in line in each spare and empty raceway.

3.05 RACEWAY INSTALLATION - SPECIAL AREAS

A. Raceways Exposed to Different Temperatures: Where portions of an interior raceway system are exposed to widely different temperatures, seal interior and exterior of raceway to prevent circulation of air from a warmer to a colder section through the raceway installation.

B. Refrigerated Rooms: Install conduit body or junction box in the raceway system on warm side of refrigerated room. After conductors are installed, seal interior of the raceway at the conduit body or junction box.

C. Heated Areas to Unheated Areas: After conductors are installed, seal interior of the raceway at the nearest conduit body, outlet or junction box in the heated area adjoining the unheated area.

D. Conduit for Prefabricated Walk-In Refrigeration Boxes:

E. Install box wiring in conduit. Run conduit exposed on exterior of box unless project conditions require conduit to be run exposed on interior of box.

F. Install rigid ferrous metal conduit and galvanized fittings where the metal surfaces are galvanized steel.

G. Install rigid stainless-steel conduit and fittings where the metal surfaces are stainless steel.

H. Create a thermal break where penetrating the box by installing maximum of 12 inches of Schedule 40 high density polyethylene conduit within the conduit run at the penetration. Seal the penetration.

I. Install equipment grounding conductor in each conduit.

J. Seal raceway as specified for raceways exposed to different temperatures.

K. Conduits in Heating Tunnels: Install rigid ferrous metal conduit exposed in the tunnel and run conduit to avoid manhole entrances and other obstructions. Install equipment grounding conductor in each conduit.

L. Conduit in Waterproofed Floors: Install conduit runs in waterproof floors to avoid penetrating the waterproofing. Avoid penetration of waterproofing with conduit risers so far as practicable.

M. Where it is necessary to puncture the waterproofing for a conduit riser, install a standard weight steel pipe sleeve extending one inch above the finished floor level. Flash the steel pipe sleeve to the waterproofing with 16-ounce copper. Construct the flashing with a copper tube extending the full height of the sleeve, soldered to a copper base extending 6 inches in all directions from the sleeve.

N. The flashing will be integrated into the waterproofing by the Construction Contractor. Provide solid cast brass floor plates with chromium finish where pipe sleeves are exposed in rooms.

O. Conduit in Hazardous Areas: Install Work in hazardous areas in accordance with the NFPA 70. The hazardous areas and the degree of hazard for each area are indicated on the drawings.

P. Install sealing fittings in concealed conduit runs in a recessed box with blank face plate to match other face plates in the area.

3.06 RACEWAY SCHEDULE

A. Rigid Ferrous Metal Conduit: Install in all locations unless otherwise specified or indicated on the drawings.

B. Intermediate Ferrous Metal Conduit: May be installed in all dry and damp locations except:

1. Hazardous areas.
2. Where other type raceways are specified or indicated on the drawings.

C. Electrical Metallic Tubing:

1. May be installed concealed as branch circuit conduits above suspended ceilings where conduit does not support fixtures or other equipment.

2. May be installed concealed as branch circuit conduits in hollow areas in dry locations, including:
   a) Hollow concrete masonry units, except where cores are to be filled.
   b) Drywall construction with sheet metal studs, except where studs are less than 3-1/2 inches deep.
3. May be installed exposed as branch circuit conduits in dry non-hazardous locations at elevations over 10'-0" above finished floor where conduit does not support fixtures or other equipment.

D. Flexible Metal Conduit: Install equipment grounding conductor in the flexible metal conduit and bond at each box or equipment to which conduit is connected:

1. Use for final conduit connection to recessed lighting fixtures in suspended ceilings. Use 4 to 6 feet of flexible metal conduit, minimum size 1/2 inch, between junction box and fixture. Locate junction box at least 1 foot from fixture and accessible if the fixture is removed.

2. Use 1 to 3 feet of flexible metal conduit for final conduit connection to:

3. Emergency lighting units.

4. Dry type transformers.

5. Motors with open, drip-proof or splash-proof housings.

6. Equipment subject to vibration (dry locations).

7. Equipment requiring flexible connection for adjustment or alignment (dry locations).
8. Use for concealed branch circuit conduits above existing non-removable suspended ceilings where rigid type raceways cannot be installed due to inaccessibility of space above ceiling.

9. May be installed concealed as branch circuit conduits in drywall construction with sheet metal studs, except where studs are less than 3-1/2 inches deep.

E. Liquid-tight Flexible Metal Conduit: Install equipment grounding conductor in liquid-tight flexible metal conduit and bond at each box or equipment to which conduit is connected:

1. Use 1 to 3 feet of liquid-tight flexible metal conduit (UL listed and marked suitable for the installation's temperature and environmental conditions) for final conduit connection to:
   a) Motors with weather-protected or totally enclosed housings.
   b) Equipment subject to vibration (damp and wet locations).
   c) Equipment requiring flexible connection for adjustment or alignment (damp and wet locations).

3.07 FITTINGS AND ACCESSORIES SCHEDULE

A. General:

1. Use fittings and accessories that have a temperature rating equal to, or higher than the temperature rating of the conductors to be installed within the raceway.

2. Use zinc electroplate or hot dipped galvanized steel/malleable iron or cast-iron alloy fittings and accessories in conjunction with ferrous raceways in dry and damp locations unless otherwise specified or indicated on the drawings.

3. Use insulated grounding bushings or grounding wedges on ends of conduit for terminating and bonding equipment grounding conductors, when required, if cabinet or boxes are not equipped with grounding/bonding screws or lugs.

4. Use caps or plugs to seal ends of conduits until wiring is installed to exclude foreign material.

5. Use insulated grounding bushings on the ends of conduits that are not directly connected to the enclosure, such as stub-ups under equipment, etc., and bond between bushings and enclosure with equipment grounding conductor.

6. Use expansion fittings where raceways cross expansion joints (exposed, concealed, buried).

7. Use deflection fittings where raceways cross expansion joints that move in more than one plane.

8. Use 2 locknuts and an insulated bushing on end of each conduit entering sheet metal cabinet or box in dry or damp locations.

9. Plastic bushing may be used on 1/2- and 3/4-inch conduit in lieu of insulated bushing.

10. Terminate conduit ends within cabinet/box at the same level.

B. For Rigid and Intermediate Metal Conduit: Use threaded fittings and accessories. Use 3-piece conduit coupling where neither piece of conduit can be rotated.

C. For Electrical Metallic Tubing: Use compression type connectors and couplings.

D. For Flexible Metal Conduit: Use flexible metal conduit connectors.

E. For Liquid-tight Flexible Metal Conduit: Use liquid-tight connectors.

F. For Rigid Nonmetallic PVC Conduit: Use conduit manufacturer's standard fittings and accessories.

G. For Plastic Coated Rigid Metal Conduit: Use conduit manufacturer's PVC coated fittings and accessories.

END OF SECTION

SECTION 260534 - SURFACE RACEWAYS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract including the General and Supplementary Conditions of Division 1 of the Specification Sections, apply to the work of this section.

1.02 SECTION INCLUDES

A. Surface metal raceways.

B. Multi-outlet assemblies.

C. Wireways.

1.03 REFERENCES

A. NECA (National Electrical Contractor's Association) Standard of Installation.

B. NEMA WD 6 - Wiring Device Configurations.

1.04 QUALITY ASSURANCE

A. Perform Work in accordance with NECA Standard of Installation.

1.05 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum (3) years experience.

PART 2 - PRODUCTS

2.01 SURFACE METALLIC RACEWAY

A. Combination Power and Data Cables:

1. 1.75" H x 4.75"W.

2. Metallic two-piece raceway with single or split compartment as called for on plans.

3. Color shall be Ivory color durable finish scratch-resistant surface that can be painted.

4. Provide the following fittings:
   a) Entrance End Fitting: nominal maximum dimensions of 4.75"W x 3"H x 4"L and 2.5" or 2" conduit openings

   b) Back Entrance End Fitting: same as entrance end fitting with internal radius.

   c) T fittings.

   d) Flat internal and external elbows with fiber optic radius.

5. Design Make: Mono-Systems SMS4200 series raceway, with SMS4205 SMS4214FO, SMS4211FO and SMS4209FO fittings

6. Acceptable Manufacturers:
   a) Mono-Systems SMS4200 Series.
   b) Wiremold 4000 Series.

B. Single Branch Circuit or Data Cable

1. One-piece raceway
2. Color shall be Ivory
3. Utilized for wall mounted phones and miscellaneous branch circuit power only.
4. Provide internal and external 90-degree fittings with radius.
5. Design Make: Mono Systems SMS700
6. Acceptable Manufacturers:
   a) Mono-Systems SMS700 Series.
   b) Wiremold 700 Series.

C. Provide miscellaneous boxes, extension rings, fittings and supports designed and manufactured by the raceway manufacturer as required making a complete job.

2.02 WIREWAY

A. Manufacturers:

1. Square D.
2. Substitutions: Refer to Division 1.

B. Description: General purpose, Oil-tight, dust-tight, and Rain-tight type wireway.

C. Knockouts: Manufacturer's standard.

D. Size: As indicated on Drawings.

E. Cover: Hinged cover.

F. Connector: Flanged.

G. Fittings: Lay-in type with removable top, bottom, and side; captive screws.

H. Finish: Rust inhibiting primer coating with gray enamel finish.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Support with expansion anchors, concrete inserts, masonry inserts or toggle bolts as field conditions require. Provide supports at five-foot centers.

B. Install a separate green ground conductor in raceway from the junction box where surface raceway begins to the ground terminal of the device, fixture or equipment being supplied.

C. Provide all fittings, connectors, elbows, tees, boxes etc. as required for the installation.

D. Submit factory drawings detailing the installation. Include a complete part list.

E. Raceway shall be factory painted. Touch up raceway and outlet boxes as required upon completion of installation.

F. Provide new covers and device brackets in areas where existing raceway is called for reuse. Paint raceway to match existing upon completion.

G. Provide all required conduit entrance end fittings and elbows required for a complete installation.

H. Raceway shown on plans is diagrammatical only. Route raceway around existing room features as required.

I. Where existing conduits, pipes and other obstacles interfere with the installation of new raceway at 90-degree angles, provide bridge fittings to traverse the obstacle without rerouting. If this is not possible reroute the surface raceway or the existing raceway as directed by owners' representative.

J. Install Products in accordance with manufacturer's instructions.

K. Use flat-head screws, clips, and straps to fasten raceway channel to surfaces. Mount plumb and level. This shall be done for WM400BAC as well, even though raceway comes with adhesive.

L. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.

M. Wireway Supports: Provide steel channel as specified in section 260190.

N. Close ends of wireway and unused conduit openings.

O. Ground and bond under provisions of section 260526.

END OF SECTION

SECTION 260535 - CABLE TRAYS AND HANGERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the contract including the general and supplementary conditions of division 1 of the specification sections, apply to the work of this section.

1.02 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

1.03 DESCRIPTION OF WORK

A. This section includes minimum requirements for the following:

1. Solid Bottom Cable Tray.
2. Cable Hangers.

1.04 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code.

B. ASTM A123 - Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip.

C. ASTM A653 - Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality.

D. ASTM A1011 - Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High Strength Low Alloy with Improved Formability (Formerly ASTM A570 &A607).

E. ASTM A1008 - Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability (Formerly ASTM A611).

F. ASTM B633 - Specification for Electrodeposited Coatings of Zinc on Iron and Steel.

G. NEMA VE 1-Metallic Cable Tray Systems.

H. NEMA VE 2- Cable Tray Installation Guidelines.

I. IEC 61537 - Cable Tray Systems and Cable Ladder Systems for Cable Management.

J. TIA 569-A - Commercial Building Standard for Telecommunications Pathways &Spaces.

K. ASTM A 510 - Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.

L. ASTM A 380 - Specification for Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.

1.05 QUALITY ASSURANCE

A. All trays and hangers shall be installed in a neat and workmanlike manner. 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 Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

1.06 SUBMITTALS

A. Provide product data for the following all materials specified in this section.

B. Provide coordination drawings indicating locations of cable tray.

PART 2 - PRODUCTS

2.01 SOLID BOTTOM CABLE TRAY

A. Flat Solid Bottom Cable Trays shall be painted steel construction, including accessories. One piece construction bottom and sides. Provide all required fittings for a complete system.

B. Standard length of 10'-0" per section.

C. Refer to plans for sections requiring hinged screw covers.

D. Wrap around type bolted connector to connect tray sections.

E. Minimum inside radius of horizontal elbows shall be 12 in. Provide special radius elbows where required for field conditions. Horizontal and Vertical bends for flat solid bottom trays shall have solid bottoms.

F. Support cable tray as recommended by manufacture. Provide a safety loading factor of 1.5 for uniformly distributed loads when supported as a simple span in accordance with the NEMA standard listed.

G. Cable tray, cover, and all supporting devices shall be painted to match existing surroundings where exposed. Cable tray and cover shall be painted by the manufacture with a baked on black finish.

H. Available dimensions:

1. 12"W x 4"D

I. Design Make: Mono-Systems SB Series.

J. Acceptable Manufacturers:

1. Monosystems
2. B-Line/Cooper
3. Cablofil/Legrand

2.02 CABLE HANGERS

A. Provide prefabricated, zinc coated, carbon steel or aluminum open top hangers designed specifically for Category 5E, Category 6 and Optical Fiber cable installations.

B. Hangers shall have open top, rolled edges with a 2" or 4" diameter loop as cable quantities require.

C. Provide beam clamps, rod fasteners, flange clips and brackets as job conditions require.

D. Provide nylon/velcro type cable ties to hold cables in hangers install ties at the completion of the cable installation.

E. Design Make: Erico Caddy "CableCat Clip" series.

F. Acceptable Manufacturers:

1. Erico.
2. Monosystems.
3. B-Line/Cooper.
4. Cablofil/Legrand.

PART 3 - EXECUTION

3.01 ALUMINUM CABLE TRAYS

A. Hang Cable tray using threaded, galvanized rod hangers, with rods extended through support steel and double-nutted. Size support member within load rating of member section; and without visible deflection. Install cable tray level and straight.

B. Provide aluminum body expansion connectors at building expansion joints. Minimum 4 in. movements, greater if expansion movement conditions warrant.

C. Provide external grounding strap at expansion joints, sleeves, crossovers and at other locations where tray continuity is interrupted.

D. Provide necessary elbows, tees, crosses, risers, offsets, fittings, reducers, connectors, clamps, rod suspension, trapeze hangers, etc., as required to make a complete job, coordinate with the manufacturer.

E. Provide conduit to tray fitting at each conduit entrance to tray.

F. Provide (1) piece of 1/2" EMT conduit or snap on covers on each threaded rod hanger to prevent scoring of cable insulation when cable is pulled in.

G. Refer to cable tray installation detail on the contract documents for additional requirements.

H. Install fire stop wall frames around cable tray at penetrations through fire rated walls, and where called for. Seal these openings with pliable fire resistant sealant.

3.02 CABLE HANGERS

A. Provide cable hangers 4' on center wherever cable tray or conduit is not present.

B. Load hangers as recommended by the manufacturer. Provide hangers side by side on a common bracket where cable quantities require.

C. Do not support cable from ceiling system tie wires or grid in fire rated systems.

D. Provide a minimum of (1) spare hanger run in all corridors.

E. Suspended cables must be installed with at least 3 in of clear vertical space above the ceiling tiles and support channels (T-bars).

END OF SECTION

SECTION 260540 - BOXES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract including the General and Supplementary Conditions of Division 1 of the Specification Sections, apply to the work of this section.

1.02 WORK INCLUDES

A. Wall and ceiling outlet boxes.
B. Pull and junction boxes.

1.03 REFERENCES

A. NECA - Standard of Installation.
B. NEMA FB 1 - Fittings and Supports for Conduit and Cable Assemblies.
C. NEMA OS 1 - Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
D. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports.
E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
F. NFPA 70 - National Electrical Code.

1.04 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Provide Products listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.05 SUBMITTALS FOR REVIEW

A. Provide Product Data for the following:

1. High Capacity wall Boxes

PART 2 - PRODUCTS

2.01 OUTLET BOXES

A. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel. Not less than 1-1/2" deep, 4" square or octagonal, with knockouts. Outlet boxes exposed to moisture, exterior, wet or damp locations shall be cadmium cast alloy complete with threaded hubs and gasketed screw fastened covers. Minimum box size shall be as indicated in Article 314 of the National Electrical Code for the conductors and devices installed. Boxes shall be approved for the environmental condition of the location where they will be installed.

B. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 1/2" male fixture studs where required.

C. Acceptable manufacturers:

1. Steel City
2. Raco
3. Appleton
4. Crouse Hinds

2.02 PULL AND JUNCTION BOXES

A. Sheet Metal Boxes: NEMA OS 1, galvanized steel. Shall be constructed of not less than 14-gauge galvanized steel with trim for flush or surface mounting in accordance with the location to be installed. Provide screw-on type covers. Boxes installed in damp or wet locations shall be of raintight construction with gasketed cover and threaded conduit hubs. In no case shall boxes be sized smaller than as indicated in Article 314 of the National Electrical Code for conduit and conductor sizes installed. Boxes shall be approved for the environmental condition of the location where they will be installed.

2.03 TERMINAL AND EQUIPMENT CABINETS IN NON HAZARDOUS LOCATIONS

A. Steel Equipment Cabinets shall be code gauge galvanized steel with removable end walls. Fronts shall be of code gauge steel, flush or surface type (as indicated) with concealed trim clamps, concealed hinges, flush lock, and grey baked enamel finish. Boxes and front shall be U.L. listed and shall be minimum 24"H x 24"W x 6"D or as called for on plans. Provide provisions for terminal board mounted on inside back wall of cabinet as required.

B. Fiber glass equipment cabinets shall be Compression-molded fiberglass for chemical and temperature-resistance. Gasketed for water-tight and dust-tight seal. Polyester mounting brackets and stainless-steel attachment screws, molded-in-place threaded brass inserts and plated steel screws for mounting optional panels and terminal block kits. Removable hinged cover attached to body with Type 316 stainless steel hinge pin or Screw-cover enclosure secured with two captivated Type 316 stainless steel slotted cover screws.

C. Stainless Steel terminal and equipment cabinets shall have continuous hinge, seamless foam-in-place gasket and stainless-steel screw-down clamps for a reliable seal that protects components from corrosive environments. 14-gauge Type 304 stainless steel with seams continuously welded and ground smooth, seamless foam-in-place gasket. Weldnuts for mounting optional panels and terminal block kits. Provide bonding provision on door and body.

D. Poly carbonate boxes shall be non-glass-filled polyester material offers superior UV resistance. Chemical resistance to a broad range of solvents, alkalis and acids. Crack and impact resistant. Shall be recyclable.

E. Provide following accessories and options where called for.

1. Continuous hinged door (unless otherwise noted provide screw type covers).
2. Scratch-resistant polycarbonate windows permanently bonded in place.
3. Quick-release latches and corrosion-resistant polyester latches located in corners that provide unobstructed access to enclosure.
4. Padlock provisions in latch.

F. Provide the NEMA type listed below as required for the environment and use:

1. Type 1: for indoor use to provide a degree of protection to personnel against access to hazardous parts and to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt).

2. Type 3R: for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow); and that will be undamaged by the external formation of ice on the enclosure.

3. Type 4X: for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (windblown dust); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose directed water); that provides an additional level of protection against corrosion; and that will be undamaged by the external formation of ice on the enclosure.

4. Type 12: for indoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt and circulating dust, lint, fibers, and flyings); and to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (dripping and light splashing).

G. Acceptable Manufacturers:

1. Hoffman
2. Thomas & Betts
3. Wiegmann
4. Appleton

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify locations of boxes and outlets prior to rough in. Thoroughly examine the architectural elevations and millwork shop drawings.

B. If outlets are not specifically shown on elevations and there is millwork or equipment associated with the outlets issue an RFI prior to rough in.

3.02 INSTALLATION

A. Install boxes in accordance with NECA "Standard of Installation."

B. Install in locations as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements. Install junction and pull boxes in readily accessible locations. Access to boxes shall not be blocked by equipment, piping, ducts and the like. Provide all necessary junction or pull boxes required due to field conditions and size as required by the National Electrical Code.

C. Consider location of outlets shown on drawings as approximate only. Study architectural, process piping, mechanical, plumbing, structural, roughing-in, etc., drawings and note surrounding areas in which each outlet is to be located. Locate outlet so that when fixtures, motors, cabinets, equipment, etc., are placed in position, outlet will serve its desired purpose. Where conflicts are noted between drawings, contact Owner's Representative for decision prior to installation. Comply with Article 314 of National Electrical Code relative to position of outlet boxes in finished ceilings and walls. Adjust box location up to 10 feet if required to accommodate intended purpose.

D. Orient boxes to accommodate wiring devices oriented as specified in Section 262726

E. Maintain headroom and present neat mechanical appearance.

F. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

G. Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Division 1.

H. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.

I. Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.

J. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

K. Do not install flush mounting box back to back in walls; provide minimum 6" separation.

L. Do not fasten boxes to ceiling support wires.

M. Support boxes independently of conduit.

N. Outlet boxes installed in plaster, gypsum board or wood paneled walls shall be installed with raised plaster covers or raised tile covers. Use gang box where more than one device is mounted together. Do not use sectional box.

O. Use gang box with plaster ring for single device outlets.

P. Use cast outlet box in exterior locations exposed to the weather and wet locations.

Q. Outlet boxes shall be sized to accommodate the wiring device(s) to be installed.

R. Outlet boxes installed in tile, brick or concrete block walls shall be installed with extra-deep type raised tile covers or shall be 3-1/2" deep boxes with square corners and dimensions to accommodate conductors installed.

S. Surface ceiling mounted outlet boxes shall be minimum 4" square, 1-1/2" deep, galvanized sheet metal.

T. Surface wall mounted outlet boxes shall be cast type boxes having threaded or compression type threadless hubs. Exterior boxes shall be cast type with threaded hubs and gasketed cover plates secured by non-ferrous screws.

U. Floor outlet boxes shall be installed flush with finished floor, adjust level and tilt as required. Where finished floor is terrazzo, provide boxes specifically designed for installation in terrazzo. Where floors are to receive carpet, provide floor outlet with carpet flange.

V. Unless otherwise noted, mount devices and equipment at heights measured from finished floor to device/equipment centerline as follows:

1.	Toggle switches	46"
2.	Receptacle outlets	18"
3.	Receptacle outlets, above hot water or steam baseboard heaters.	
4.	Do not install receptacle outlets above electric baseboard heaters.	30"
5.	Receptacle outlets, hazardous areas	48"
6.	Receptacle outlets, weatherproof, above-grade	24"
7.	Clock outlets	90"
8.	Telephone outlets	18"
9.	Telephone outlets, wall mounted	46"
10.	T.V. outlet	18"
11.	Fire alarm manual station	46"
12.	Fire alarm audio/visual	80"
13.	Branch circuit panelboards, to top of backbox	72"
14.	Distribution panelboards, to top of backbox	72"

15. Terminal cabinets, control cabinets 72"
16. Disconnect switches, motor starters, enclosed circuit breakers 48"
17. Where structural or other interference's prevent compliance with mounting heights listed above, consult Owner's Representative for approval to change location before installation.

3.03 INTERFACE WITH OTHER PRODUCTS

A. Coordinate installation and location of outlet box for equipment with equipment supplier and other trades as applicable.
B. Cut boxes in millwork using methods approve by manufacturer and architect.

3.04 ADJUSTING

A. Adjust flush mounting outlets to make front flush with finished wall material.
B. Adjust vertical and horizontal alignment of boxes as required.
C. Install knockout closures in unused box openings.

3.05 CLEANING

A. Clean interior of boxes to remove dust, debris, and other material.
B. Clean exposed surfaces and restore finish.

END OF SECTION

SECTION 262400 - POWER DISTRIBUTION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract including the General and Supplementary Conditions of Division 1 of the Specification Sections, apply to the work of this section.

1.02 SECTION INCLUDES

A. Circuit Breakers.
B. Branch Circuit Panelboards.
C. Disconnect Switches.
D. Low Voltage Fuses.

1.03 REFERENCES

A. The equipment referenced herein are designed and manufactured according to the following appropriate specifications.

1. ANSI/NFPA70 - National Electric Code (NEC).
2. ANSI/IEEE C12.1 - Code for Electricity Metering.
3. ANSI C39.1 - Electrical Analog Indicating Instruments.
4. ANSI C57.13 - Instrument Transformers.
5. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
6. NEMA KS 1 - Enclosed Switches.
7. NEMA PB 2.1 - Proper Handling, Installation, Operation & Maintenance of Deadfront Switchboards Rated 600V or Less.
8. NEMA PB 2.2 - Application Guide for Ground Fault Protective Devices for Equipment.
9. UL 50 - Cabinets and Boxes.
10. UL 98 - Enclosed and Deadfront Switches.
11. UL 489 - Molded Case Circuit Breakers.
12. UL 943 - Ground Fault Circuit Interrupters.
13. UL 1053 - Ground Fault Sensing and Relaying Equipment.
14. UL 977 - Fused Power Circuit Devices.
15. CSA 22.2 No. 5 - M1986 Molded Case Circuit Breakers.
16. Federal Specification W-C-375B/Gen - Circuit Breakers, Molded Case, Branch Circuit and Service.
17. Federal Specification W-C-870 - Fuseholders (for plug and enclosed cartridge fuses).
18. Federal Specification W-S-865 - Enclosed Knife Switch.
19. NECA Standard of Installation (published by the National Electrical Contractors Association).
20. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (published by the International Electrical Testing Association).
21. NFPA 70 - National Electrical Code.

1.04 SUBMITTAL FOR REVIEW

A. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker arrangement and sizes.

1.05 SUBMITTALS FOR CLOSEOUT

A. Maintenance Data: Include spare parts listing; source of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum (10) years' experience.

1.07 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect and handle products in conformance with manufacturer's recommended practices as outline in applicable Installation and Maintenance Manuals.

B. Each switchboard section shall be delivered in individual shipping splits for ease of handling. They shall be individually wrapped for protection and mounted on shipping skids.

C. Inspect and report concealed damage to carrier within their required time period.

D. Store in a clean, dry space. Maintain factory protection and/or provide an additional heavy canvas or heavy plastic cover to protect structure from dirt, water, construction debris, and traffic. Where applicable, provide adequate heating within enclosures to prevent condensation.

E. Handle in accordance with NEMA PB 2.1 and manufacturer's written instructions. Lift only by lifting means provided for this express purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

PART 2 - PRODUCTS

2.01 CIRCUIT BREAKERS

A. General:

1. Molded case circuit breakers shall be constructed of a glass reinforced insulating material. All current carrying components shall be completely insulated and isolated from the outside of the circuit breaker.

2. Provide an over-center, trip-free handle to provide quick-make, quick-break contact action.

3. Provide multi-pole breakers with common trip.

4. When the circuit breaker has tripped, the handle shall move to a position between the "on" and "off" positions. Provide a visual indication that the circuit breaker has tripped.

5. The ampere rating shall be clearly marked on the face of the circuit breaker.

6. Make provisions to add circuit breaker handle locks.

7. Circuit breakers shall have voltage, ampere, and interrupting ratings as called for on the Panelboard Schedule.

B. Thermal Magnetic Molded Case Branch Circuit Breakers:

1. Permanent trip unit containing individual thermal and magnetic trip elements.

2. Thermal trip unit shall be long time, non-adjustable, thermal overload trip.

3. Magnetic trip unit shall be instantaneous, electro-magnetic trip. Magnetic trip unit shall be adjustable for all frame sizes 225 amperes and larger.

4. Interchangeable rating plugs shall be provided for all frame sizes 400 amperes and larger.

5. 60°C terminal temperature rating for circuit breakers rated 125 amperes or below.

6. 75°C terminal temperature rating for circuit breakers rated above 125 amperes.

7. All 20 and 30 ampere, single pole circuit breakers shall be UL listed for switching duty.

8. Circuit breakers shall be bolt-on. I-Line type distribution circuit breakers are acceptable.

9. Circuit breakers rated 250 amperes and below shall be UL listed HACR type.

10. Where ground fault circuit breakers are required, provide a shunt trip circuit breaker with a zero-sequence sensing ground fault module.

11. Design Make: Square D QO, QOB (250 volt), EH, EHB (480 volt), I-Line style (600 volt).

12. Acceptable Manufacturers:
    a) Square D.
    b) General Electric.
    c) Siemens ITE.

2.02 240 VOLT BRANCH CIRCUIT PANELBOARDS

A. 240 Volt rated, maximum 400 amperes.

B. 3 Phase, 4 wire or 1 phase, 3 Wire as called for on panel schedule.

C. Copper bus bars with high dielectric thermoplastic insulators.

D. Provide continuous current ratings, short circuit current ratings, branch circuit breakers, main circuit breaker or main lugs, and flush or surface trims as called for on the Panelboard schedule.

E. Provide nameplate on each panelboard indicating voltage, current, phase, wire, and short circuit rating.

F. 100 % rated neutral of the same material as the main bus.

G. Provide ground bus of the same material as the main bus.

H. Interior trim shall be dead front construction, with pre-formed metal twist-outs covering unused mounting space.

I. Enclosures shall be nominal 20" wide by 6" deep, galvanized steel construction with removable endwalls and knockouts.

J. Fronts:

1. Surface or flush mounted as called for on the Panelboard Schedule.

2. ANSI 49 gray electrodeposited enamel.

3. Fronts shall be one piece with door and hinged to the enclosure.

4. Provide cylindrical tumbler type lock with catch and spring loaded stainless steel door pull. All locks shall be keyed alike to match existing panelboards.

5. Provide a clear plastic directory card holder on the inside of the door.

K. Design Make: Square D "NQ".

L. Acceptable Manufacturers:

1. General Electric "A" Series.
2. Siemens ITE "Sentron S1".

2.03 DISCONNECT SWITCHES

A. Three pole, single throw, or as called for on the drawings.

B. Quick-make, quick-break switch operating mechanism.

C. Heavy-duty, current rating as called for on the drawings, voltage rating as required by the equipment served.

D. All current carrying parts shall be plated to resist corrosion.

E. Lugs shall be removable and rated for 75°C temperature rating.

F. Switch blades shall be visible when the switch is in the open position and the door is open.

G. Switch shall be pad lockable in the OFF and ON positions.

H. Provide fusible switches with rejection type fuse holders and fuses as indicated on the plans or as per fed equipment requirements.

I. Provisions for a field installable electrical interlock.

J. Provide external override mechanism to open the disconnect switch door without opening the disconnect switch.

K. Enclosure shall be steel with gray baked enamel paint.

L. Provide NEMA type enclosures as called for on the drawings.

M. NEMA type 1 enclosures shall be equipped with knockouts.

N. Design Make: Square D.

O. Acceptable Manufacturers:

1. General Electric.
2. Siemens ITE.

2.04 LOW VOLTAGE FUSES

A. All fuses rated 600 volts and below shall be rejection type dual-element, time-delay type. Provide (1) complete set(s) of fuses for all fusible disconnect switches, plus (3) spare fuses of each size. Deliver spare fuses to the Owner and obtain receipt.

B. Acceptable manufacturers: Fuses 600 amperes and below: Bussman Type FRN-R (300 volts), Type FRS-R (600 volts) or equivalent.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install equipment to coordinate with installation details of other equipment associated with the power distribution system.

B. Provide miscellaneous bolts, washers, nuts, clips, lock washers, small hardware, etc., of durium or equal rust resistant material, to make a complete installation.

C. Provide complete installation in strict accordance with the equipment manufacturer's instructions, drawings and recommendations and as called for.

D. In the event of conflict, discrepancy or difference between manufacturer's instructions and Contract Documents, the more stringent requirements shall apply.

E. Unload, move, handle, set in place, install, erect, assemble, connect, test, and operate, etc. all items of electrical equipment as required.

F. Provide rigging to unload, move, transport, set in place, erect, etc. the switchboards.

G. Provide grounding as called for.

H. Provide minimum working clearance as described in NEC Article 110-26 and 110-34 for all electric equipment.

I. Provide additional working or aisle clearance as called for.

J. Verify cable/lug sizes for terminations. Where a feeder is sized larger than the lug, provide in-line splice to reduce conductor size to match equipment or breaker terminations.

3.02 INSTALLATION OF PANELBOARDS

A. Install panelboards in accordance with NEMA PB 1.1 and the NECA "Standard of Installation."

B. Install panelboards plumb. Install recessed panelboards flush with wall finishes.

C. Height: 6 feet to top of panelboard if possible. If required, install panelboard with the so that the center operating grip of the top breaker is not more than 6'-7" above the finish floor.

D. Provide filler plates for unused spaces in panelboards.

E. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads.

F. Provide engraved plastic nameplates under the provisions of section 260195.

G. Ground and bond panelboard enclosure according to section 260526.

H. Securely support all panelboard enclosures to walls. Install true and level.

I. Provide four empty 3/4" conduits and one empty 1-1/2" conduit from each flush mounted panelboard backbox to the accessible ceiling space.

J. Provide channel support between the wall and backbox for panelboards installed on outside walls.

K. Tighten all bolt and lug connections using a torque wrench or screwdriver per the manufacturer's recommendations.

L. Measure steady state load currents on each panelboard feeder. Rearrange branch circuits in the panelboard to balance the load within 20% of each other. Maintain proper phasing.

M. For buildings with more than one nominal voltage system, provide permanently post label at each panelboard indicating the color coding of all phase, neutral, and grounding conductors.

3.03 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.4 for switches, and Section 7.5 for circuit breakers.

3.04 ADJUSTING

A. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 20% of each other. Maintain proper phasing for multi-wire branch circuits.

END OF SECTION

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract including the General and Supplementary Conditions of Division 1 of the Specification Sections, apply to the work of this section.

1.02 SECTION INCLUDES

A. Wall switches.
B. Receptacles.
C. Occupancy Sensors.
D. Cover plates.
E. Cord Reels.
F. Emergency Shut-Down Stations.
G. Lighting Contactor.

1.03 REFERENCES

A. NECA - Standard of Installation.
B. NEMA WD 1 - General Requirements for Wiring Devices.
C. NEMA WD 6 - Wiring Device - Dimensional Requirements.
D. NFPA 70 - National Electrical Code.

1.04 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum (3) years' experience.

1.05 COORDINATION

A. The contractor and lighting fixture manufacturer are responsible for coordinating and guaranteeing that the driver/ballast dimmer combination will dim the driver or ballast to 1% or 10% as applicable. Utilize design make or acceptable manufacturers where possible. Provide equivalent devices from alternate manufacturers where required.

1.06 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Provide Products listed and classified by Underwriters Laboratories, Inc., as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.01 GENERAL

A. Color of devices shall be as selected by the Architect.

B. Emergency receptacles must be Red or have a red indicating "dot".

C. Where devices are added to existing facilities the color shall match other existing devices in the room or vicinity.

D. All devices must be specification grade at a minimum.

E. Where devices are ganged together provide multi-device cover plates configured as required.

F. Design Makes are from Pass & Seymour. Equivalent products from the following manufacturers are acceptable.

1. Hubbell.
2. Leviton.
3. Lutron.

2.02 SPECIFICATION GRADE SWITCHES

A. Specification Grade one-piece brass alloy contact arm for reliable electrical performance.

B. One-piece steel strap with integral ground is plated for corrosion resistance.

C. High strength thermoplastic polycarbonate toggle resists breaking and chipping under heavy abuse.

D. Heavy-duty toggle bumpers for smooth and quiet operation.

E. Back body made of glass-reinforced nylon.

F. Locking support provides resistance to face and back body separation.

G. Available with side wire or external screw-pressure-plate back and side wire models capable of accepting #14 - #10 AWG copper or copper-clad wire.

H. Cam designed for fast make with positive break action to minimize arcing and prolong switch life.

I. Oversized silver alloy contacts for longer dependable switch life.

J. Provide double pole, single pole, three way or four way as called for or required.

K. 120/277V, 20 Ampere rated.

L. Design Make: Pass and Seymour CSB series.

2.03 KEY SWITCHES

A. 120-277 VAC, 20 ampere rated.

B. Locking type. Provide (1) key per switch, all keyed alike.

C. Side or back wired.

D. Quiet operation with key removable in both positions.

E. Single pole, three-way, and four way as called for on the plans.

F. Design Make: Pass & Seymour PS20AC series.

2.04 DIMMERS

A. Line Voltage Four Wire Fluorescent and LED:

1. For use with 0-10V, 4 wire, 120V and 277V dimming ballasts and drivers.

2. Field configurable wall plate system.
3. Labeling system.
4. Adjustable low-end output voltage.
5. Rugged construction.
6. Minimum of de-rating when ganged.
7. Integrated power pack.
8. Single pole slide-to-OFF and single pole/3-way as required.
9. Design Make:
    a) Pass & Seymour CD4FBL Series (Single Pole).
    b) Pass & Seymour CD4FBL3P Series (3-Way).

2.05 OCCUPANCY SENSORS

A. Ceiling Mounted Sensors:

1. Advanced signal processing circuitry helps to eliminate false ONs.

2. Utilizes advanced, omni-directional (360 degrees), Doppler technology for reliable occupancy detection.

3. Angled transmitter and receiver pairs help optimize sensitivity while eliminating unwanted detection from ceiling air movement.

4. Digital DIP switch time delay (15 seconds to 30 minutes).

5. LED indicates occupancy detection.

6. Reliable solid-state construction.

7. Temperature and humidity resistant 32 kHz receivers.

8. Mounts to ceiling tiles or box.

9. Units per power pack: up to 4.

10. UL listed.

11. 5-year warranty.

12. Design Make: Pass & Seymour;
    a) CSU600 (rooms less 500 square feet).
    b) CSU1100 (rooms 500-1000 square feet).
    c) CSU2200 (rooms 1000-2000sqare feet).

B. Wall Switch Sensor:

1. Detection Signature Analysis for high immunity to RFI and EMI.

2. Compact, decorator design replaces existing wall switch.

3. Integrated light level sensor works from 10 to 150 foot-candles.

4. Compatible with all electronic and magnetic ballasts, PL lamp ballasts, compact fluorescent.

5. Adjustable time delay of 30 seconds to 30 minutes.

6. Dual 120/277VAC operation.

7. Positive detection indicator.

8. No minimum load requirement.

9. Adjustable sensitivity from 20% to 100%.

10. 180 degree coverage of up to 900 sq. ft.

11. 5-year warranty.

12. Design Make: Pass & Seymour WSP200 series

C. Vacancy Sensor:

1. Manual-ON operation. Auto adjustable time delays: automatic, fixed (5, 10, 15, 20, 25 or 30 minutes), walk-through, test-mode.

2. Selectable time delay automatically adjusts. Selectable walk-through mode turns lights off three minutes after the room is initially occupied if no motion is detected after the first 30 seconds. Selectable test mode allows quick and easy adjustments.

3. Selectable audible alert for impending shutoff.

4. LED indicating occupancy detection.

5. Built-in light level sensing with simple, one-step setup.

6. Override mode allows sensor to operate as a service switch in the event of a failure. NEMA WD 7 guideline utilized for coverage testing. Sensitivity adjustment: PIR (high/low).

7. Coverage: 180 degrees, up to 1050 sq. ft.; major motion 35' x 30'; minor motion 20' x 15'.

8. 5-year warranty.

9. Loads: Incandescent, fluorescent, compact fluorescent (CFL), magnetic low-voltage (MLV) and electronic low-voltage (ELV), 1/6 hp.

10. Design Make: Pass & Seymour OS300SW.

D. Dimmable wall switch Occupancy/Vacancy Sensor

1. For use with 0-10V, 4 wire, 120V and 277V dimming ballasts and drivers.

2. Pressing and holding the UP button will ramp the lights up to the maximum value as determined by the high trim setting. Pressing and holding the DOWN button will dim the lights down to the minimum value as determined by the low trim setting. By default, the values are set at 100% (10v) for high trim and OFF (0v) for low trim.

3. Automatic-ON (Occupancy) or Manual-ON (Vacancy) operation. Refer to plans for Occupancy and Vacancy Sensor requirements and adjust dip switches accordingly to either Automatic-ON (Occupancy) or Manual-ON (Vacancy).

4. Adjustable time delay from 3, 5, 15 and 30 minutes.

5. Multi-way wiring available up to 4 sensors. All switches can sense each other’s dimming events and respond accordingly.

6. 180 degree field of view for use in spaces no larger than 12’ x 15’.

7. Design Make: Pass & Seymour PW-311.

E. Power Packs:

1. Provide power packs for low voltage control devices.

2. Universal Voltage Pack with 24 VDC operating voltage to low-voltage occupancy sensors and similar controls.

3. High-efficiency power supply and a high-current relay. Transformer with a primary high voltage input, and a secondary low-voltage output (24 VDC, 114 mA, with relay connected)

4. Secondary output will turn the connected load on and off automatically based on device input.

5. When the lighting system detects motion or inadequate ambient light, sensor shall electrically close an internal circuit which sends 24 VDC back to the Power Pack.

6. Design Make Pass & Seymour BZ-150 series.

2.06 DUPLEX RECEPTACLES

A. Dual mechanical shutter system to help prevent insertions of foreign objects.

B. Two drive screws anchor strap to back body and face where abrupt removal torque is greatest.

C. 0.032-inch-thick brass triple-wipe power contacts for lasting retention.

D. Corrosion-resistant plated steel strap is locked in to the face and back body to resist pulling away from the face/body assembly.

E. Auto-ground clip for positive ground.

F. Easily accessed break-off line-contact connecting tab for fast and easy split-circuit wiring.

G. Backed-out tri-drive steel terminal screws.

H. Side wire capability.

I. Design Make: Pass & Seymour TR20 series.

2.07 GFCI RECEPTACLES

A. Dual mechanical shutter system to help prevent insertions of foreign objects.

B. 20 ampere rated.

C. No exposed terminals to a finger safe application before, during, and after installation.

D. Built-in connector features large brass terminal blades to ensure consistent, reliable electrical connections to Plug Connector.

E. Protection: if critical components are damaged and ground fault protection is lost, power to receptacle is disconnected.

F. Prevents line-load reversal miswire: no power to the face or downstream receptacles if wired incorrectly.

G. FSUL Listed (Federal Specification WC596).

H. Exceeds UL943 voltage surge requirements; survives 100x the required UL 3kA/6kV voltage surge test cycles.

I. Trip indicator light (red LED).

J. Mounting screws are shipped captive in the device and wall plate for easier installation.

K. High-impact-resistant thermoplastic construction.

L. Zinc-plated steel mounting strap.

M. Button colors matching the device face.

N. Dual-direction test and reset buttons.

O. Class A rated GFCI.

P. Design Make: Pass & Seymour 2097TRRI Series.

2.08 USB CHARGER W/ TAMPER-RESISTANT 20A DUPLEX RECEPTACLE

A. UL Listing No: Complies with test requirements UL498, UL1310

B. 20A rated

C. Back and side wire terminals accommodate #14 AWG - #10 AWG stranded and solid copper wire.

D. Design Make: Pass & Seymour: TR5362USB.

2.09 COVER PLATES

A. Stainless Steel Cover Plates:

1. Type 302 or 304, satin finish, 0.040" thick, accurately die cut, protected with release paper.

2. Flush mounting plates shall be beveled with smooth rolled outer edge.

3. Surface mounting plates shall be beveled and pressure formed for smooth edge to fit box.

4. Where two-gang boxes are required for single gang devices. Provide special plates with device opening in one gang and second gang blank.

B. Weatherproof Cover Plates:

1. Weatherproof plastic in-use cover
2. Horizontal/vertical cover in clear MM410C that safely covers any electrical outlet
3. Universal Fit to enable same product for all types of receptacles.
4. Attached gasket and mounting hardware
5. Meet or exceeds OSHA and NEC (article 406.8[b][1] wet location requirements with the cord plugged into the receptacle.

2.10 CORD REELS

A. Industrial:

1. Durable, corrosion resistant steel construction with white powder coat finish.
2. Multi-position arm guide mounts to the ceiling, wall, floor or bench.
3. 12 AWG cord for greater current carrying capacity.
4. Positive-latch mechanism automatically maintains desired cord length.
5. Plug-in 6 ft. long power cord requires no electrical wiring.
6. Portable outlet box with (2) duplex receptacles.
7. 25 ft., 12/3 SJEO cord, 20A, 125V.
8. Design Make:
   a) KH Industries RTA Series Cord Reel RTAN3LW-WDD520-J12F.

2.11 EMERGENCY SHUT-DOWN STATIONS

A. Red Mushroom head emergency stop trigger action and mechanical latching pushbutton with the following features:

1. Normally closed contact.
2. Key release version.

B. Emergency Shutdown stations shall be installed in locations with clear unobstructed access that is a minimum 36” wide.

C. The emergency shutdown stations shall be configured to de-energize the power panels supplying shop equipment in an emergency condition.

D. Design Make: Square D Harmony XB4 metal 22 mm push buttons XB4BS9445.

2.12 LIGHTING CONTACTOR

A. Multipole, Electrically Held with the following requirements:

1. Contact Configuration: 2 Normally Open Contacts.
2. Contactor Type: Silver-Cadmium-Oxide double break contacts.
3. Dimensions: 6.03”D x 12.69”H x 7.81”W
4. Ampere Rating: 30A
5. Features: Field Convertible Contacts
6. Enclosure Rating: NEMA 1
7. Maximum Voltage Rating: 600V
8. Mounting Type: Surface
9. Number of Poles: 2.
10. Operating Voltage 120V.

B. Design Make: Square D.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Prior to installation verify that outlet boxes are cut in at proper height; that wall openings are neatly cut and will be completely covered by wall plates.

B. If wall openings were made by general trades notify that contractor and owners representative and direct the cutting and patching requirements. If the openings were made by electrical contractor cut and patch opening using a qualified trades person.

3.02 INSTALLATION

A. Install in accordance with NECA "Standard of Installation."

B. Install devices plumb and level.

C. Install switches with OFF position down.

D. Install wall dimmers to achieve full rating specified and indicated after de-rating for ganging as instructed by manufacturer.

E. Do not share neutral conductor on load side of dimmers.

F. Install receptacles with grounding pole on top.

G. Connect wiring device grounding terminal to outlet box with bonding jumper and to branch circuit equipment grounding conductor.

H. Install decorative plates on switch, receptacle, and blank outlets in finished areas.

I. Connect wiring devices by wrapping conductor around screw terminal.

J. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas and above accessible ceilings.

K. Install protective rings on active flush cover service fittings.

L. When receptacle is mounted horizontally, neutral pole shall be on top.

M. Provide extension rings to bring outlet boxes flush with finished surface.

N. Provide receptacles at locations indicated and where required by special equipment with plug connection. Mount at height 18" AFF; unless noted otherwise on drawings.

O. Receptacles shall not be installed back to back unless otherwise noted.

3.03 FIELD QUALITY CONTROL

A. Inspect each wiring device for defects.

B. Operate each wall switch with circuit energized and verify proper operation.

C. Verify that each receptacle device is energized.

D. Test all receptacles for proper voltage, grounding and polarity.

E. Test all GFCI receptacles for proper voltage, polarity, grounding, and verify the receptacle trips at 6 milliamperes or less.

F. Test all receptacles for polarity, ground continuity and ground blade retention force per NFPA 99 Chapter 3-3 Section 3-3.3.3.

G. Rewire receptacles as required until receptacles test properly.

H. Clean exposed surfaces to remove splatters and restore finish.

3.04 FUNCTIONAL TESTING

A. Where Dimmers, Occupancy Sensors, time switches, programmable schedule controls, photo sensors are installed, the following procedures shall be performed:

1. Confirm that the placement, sensitivity and time-out adjustments for occupant sensors yield acceptable performance.
2. Confirm that the time switches and programmable schedule controls are programmable to turn the lights off.
3. Confirm that the placement and sensitivity adjustments for the photo sensor controls reduce electric light based on the amount of usable daylight in the space as specified.

B. Contractor shall submit a written report to Architect, copy to Engineer, on results of each functional test on equipment installed. Report shall contain owner's representative's signature.

3.05 SWITCHES

A. Provide switches to control outlets, appliances, lighting, etc. as indicated. Mount 48" above finished floor unless noted otherwise.

B. Do not feed thru local switches unless specifically noted.

C. Where more than one switch is indicated at one location on 120-volt circuits mount in gangs under common plate.

D. Locate switches on strike side of door. If switch is indicated at location which would be concealed (behind equipment, etc.) or not on strike side of door, obtain approval of Architect before installation.

E. Switches shall not be installed back to back unless otherwise noted.

3.06 DEVICE PLATES

A. Provide at locations indicated with size openings required for devices indicated.

3.07 WALL PLATES

A. Provide at locations indicated with size openings required for devices indicated.

B. Multi-gang switches, receptacles, etc. shall be in a common one-piece plate.

END OF SECTION

SECTION 265010 - LIGHTING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract including the General and Supplementary Conditions of Division 1 of the Specification Sections, apply to the work of this section.

1.02 SECTION INCLUDES

A. Interior luminaires and accessories.
B. Exit signs.
C. Emergency lights.
D. LED drivers and light engines.

1.03 STANDARDS REFERENCES

A. Consortium for Energy Efficiency (CEE).

B. NYSERDA performance-based rebate program.

C. NYSERDA pre-qualified rebate program.

D. Design Lighting Consortium (DLC).

E. Energy Star.

F. NEMA Compliance: Comply with applicable requirements of NEMA Standards Pub. No. LE-1 and LE-2 pertaining to lighting equipment.

G. ECCC of NYS Compliance: Comply with applicable requirements of the Energy Conservation Construction Code of NYS, Section 805.

H. ANSI 132.1.

I. ANSI C78.379: Electric Lamps Incandescent and High Intensity Discharge Reflector Lamps Classification of Beam Patterns.

J. ANSI C82.1: Ballasts for Fluorescent Lamps Specifications.

K. ANSI C82.4: Ballasts for High Intensity Discharge and Low-Pressure Sodium Lamps (Multiple Supply Type).

L. ANSI/UL Compliance: Comply with ANSI/UL standards pertaining to lighting fixtures for hazardous locations.

M. UL Compliance: Provide lighting fixtures which have been UL listed and labeled.

N. CBM Labels: Provide fluorescent lamp ballasts which comply with Certified Ballast Manufacturer's Association standards and carry the CBM label.

O. FCC Part 15

P. IEEE C62.41: Guide for Surge Voltages in Low-Voltage AC Power Circuits.

Q. NFPA 70: National Electrical Code.

R. NFPA 101: Life Safety Code.

S. Testing Standards: IESLM79- 08.

T. UL1449 3rd Edition Type 4-Surge Protective Devices.

U. RoHS Compliant (Restriction of Use of Hazardous Substances).

1.04 SUBMITTALS FOR REVIEW

A. Product Data: Provide dimensions, ratings, and performance data. Information on each fixture shall include:

1. Manufacturer and Catalog Number.
2. Dimensioned Construction Drawing(s).
3. Standard Catalog "Cut" Sheet with options highlighted.
4. Photometric Data.
5. Ballast or Driver specifications.
6. Socket Type.
7. Lamp Type.
8. Energy star compliance.
9. CEE compliance.

B. Submit manufacturer's operation and maintenance instructions for each product.

1.05 QUALITY ASSURANCE

A. Lighting fixtures shall be standard products of manufacturers regularly engaged in the manufacture of the specific type lighting fixtures specified and shall be the manufacturer's latest standard design that complies with specification requirements. Firms installing the fixtures shall have a minimum of (5) years of successful installation experience on projects with interior lighting work similar to the requirements of this project.

B. Verify the availability of all fixtures proposed to be used in the execution of the work prior to submitting for approval. The discontinuance of production of any fixture after such approval has been granted shall not relieve the Contractor from furnishing an approved fixture of comparable quality and design at no additional cost.

C. Lighting fixtures shall be as specified in the "Luminaire Schedule." Fixture types, characteristics, photometrics, finishes, etc., correspond to the first manufacturer, and associated catalog number, listed in the "Luminaire Schedule." Provide a sample fixture from the factory for any products not listed as acceptable for approval. The Owner's Representative reserves the right to disapprove any fixture type submitted which is not equal in quality, appearance or performance to the fixture specified.

D. Drivers and LED boards: The manufacturer shall provide written warranty against defects in material or workmanship, including replacement, for five years from date of manufacture. Drivers and LED boards shall be manufactured in an ISO 9002 Certified Facility.

PART 2 - PRODUCTS

2.01 LUMINAIRES

A. Manufacturers:

1. Refer to lighting fixture schedule on the drawings for manufacturer and specifications.

2.02 LED DRIVERS AND LIGHT ENGINES

A. Acceptable Manufacturers:

1. Philips.
2. Lutron.
3. Microsemi.
4. Approved Equal.

B. General Requirements:

1. The LED driver and board shall have a (5) year warranty.

2. LED lamps shall have a minimum rated life 50,000 hours.

3. LED driver board combinations shall deliver a minimum of 90 lumens/watt.

4. Shall be rated dual voltage 120/277V.

5. Must have surge suppression protection suitable for use in permanently connected products meeting UL1449 3rd Edition Type 4.

6. Must meet ANSI C62.41 Category A surge protection standards up to and including 4 kV.

7. Light engine shall provide 4,000K color temperature.

C. General LED Driver Requirements:

1. LED Driver shall be installed inside an electrical enclosure.

2. Wiring inside electrical enclosure shall have a 600V/105°C rating or higher.

3. Must tolerate sustained open circuit and short circuit output conditions without damage.

4. Maximum allowable case temperature of 70°C.

5. Must comply with the requirements of UL, FCC, ENEC, CE, CQC.

6. The input and output connections shall be factory wiring only. Connection to supply mains shall be determined in the end product.

7. Temperature tested in a 55°C ambient, with the maximum temperatures on the enclosure of 73.1°C.

8. Suitable for use in dry and damp locations.

9. Installed as a built-in component of the end product. The unit shall be installed in compliance with the enclosure, mounting, spacing, casualty, temperature, and segregation requirements of the end product application.

10. The transformer shall employ a Class 130(B) insulation system.

11. Spacing in accordance with the requirements of the Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products, UL 8750, First Edition, Clause 7.8.3 and Table 7.4.

D. 0-10V Dimming Drivers:

1. Physical Characteristics:
   a) LED Driver shall be installed inside an electrical enclosure.
   b) Wiring inside electrical enclosure shall comply with 600V/105°C rating or higher.

2. Performance:
   a) Certified by UL Class2 for use in a dry or damp location.
   b) Class A sound rating.
   c) Minimum operating ambient temperature of -40°C.
   d) Life expectancy of 50,000 hours at Tcase of ≤ 70°C.
   e) Life expectancy of 100,000 hours at Tcase of ≤ 62°C.
   f) Maximum self rise of 25°C in open air without heat sink.
   g) Maximum allowable case temperature is 75°C.
   h) Failure rate ≤ 0.01% per 1,000 hours at Tcase ≤ 70°C.
   i) Failure rate of 0.01% - 0.02% per 1,000 hours at Tcase of 70°C - 80°C.
   j) Must tolerate sustained open circuit and short circuit output conditions without damage.
   k) Comply with FCC rules and regulations, as per Title 47 CFR Part 15 Non-Consumer (Class A).
   l) Minimum Dimming range 100-10%.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Locate recessed ceiling luminaires as indicated on reflected ceiling plan.

B. Install surface mounted luminaires and exit signs plumb and adjust to align with building lines and with each other. Secure to prevent movement.

C. Exposed Grid Ceilings: Fasten surface mounted luminaires to ceiling grid members using existing hardware.

D. Install recessed luminaires to permit removal from below.

E. Install recessed luminaires using accessories and fire stopping materials to meet regulatory requirements for fire rating.

F. Install clips to secure recessed grid-supported luminaires in place.

G. Install accessories furnished with each luminaire.

H. Connect luminaires, emergency lighting units, and exit signs to branch circuit outlets provided under section 260519 using flexible conduit.

I. Bond products and metal accessories to branch circuit equipment grounding conductor.

J. Install specified lamps in each exit sign, and luminaire.

K. General:

1. Install interior lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's 'Standard of Installation'', NEMA standards, and with recognized industry practices.

2. Provide fixtures and/or fixture outlet boxes with hangers to properly support fixture weight. Submit design of hangers, method of fastening, other than indicated or specified herein, for review by Engineer.

3. Make installation such that the fixture is free of finger marks, flaws, scratches, dents or other imperfections.

4. Arrangement:
   a) Align edges of fixtures with walls or other building elements. Where indicated by dimensions or indicated on drawings, maintain indicated arrangement.

   b) For wall to wall installed light fixtures, field measure length required after completion of the wall construction and prior to ordering the light fixtures. Fabricate in largest lengths allowable.

5. Recessed Mounting:
   a) Verify ceiling construction and material prior to ordering light fixtures. Provide plaster frames for plaster ceilings and flanged frames for drywall ceiling. Provide necessary mounting hardware and accessories to adapt fixture to ceiling construction. Provide gaskets, trims, flanges, etc. as required to prevent light leaks around trim. Where installing 'lay-in' type fixtures, provide galvanized supports to the building structure, independent of the ceiling system, at all four comers of the fixture. Each support shall be capable of supporting 100 pounds and each wire shall be a minimum of 12 AWG mild steel. Provide saddle hangers or tie bars attached to runners or between crossbars of ceiling systems as a safety measure. Provide mounting splines or other positive means of maintaining alignment and rigidity. Use a minimum of (2) supports independent of the ceiling for each point source type fixture.

6. Stem Mounting:
   a) Use self-aligning hangers in canopies for hanging fixtures true to vertical. Do not deface ceiling or walls. Locate hangers at intersections of joints or at centers of blocks in rooms with patterned type ceiling materials such as acoustic tile. Use hangers capable of supporting four times fixture weight. Align continuous rows of fixtures maintaining fixtures level without rotation about the longitudinal axis. Rigidly support outlet box independent of ceiling system from building structure. Where obstructions prevent direct support of outlet, provide offset or trapeze hangers of outlet box. Stem shall be supported directly from building structure on centers as called for by the manufacturer. There shall be a minimum of (2) stems per individual four-foot light fixture, and (3) stems per individual eight-foot light fixture for steel fixtures. Extruded aluminum fixtures shall have hangers as called for by the manufacturer.

7. Surface Ceiling Mounting:
   a) Mount surface fixtures tight to surface without distorting surface. Space fixtures in continuous rows to correspond to ceiling joint intersections. Continuous row fixtures may be fed by a single outlet where fixtures contain approved wireways and suitable wiring is used. Provide hangers for each fixture, each rated to support four times the fixture weight. Provide offset or trapeze hangers where required. Supports shall be provided on a maximum of 4-foot centers with a minimum of (2) hangers per individual four-foot light fixture and (3) hangers per individual eight-foot light fixture. Hangers shall be supported from the building structure and independently from ceiling system or other building services.
   b) Fasten fixtures securely to structural supports.

3.02 ADJUSTING

A. Aim and adjust luminaires.
B. Position exit sign directional arrows as indicated.

3.03 CLEANING

A. Clean electrical parts to remove conductive and deleterious materials.
B. Remove dirt and debris from enclosures.
C. Clean photometric control surfaces as recommended by manufacturer.
D. Clean finishes and touch up damage.

3.04 REUSE AND REPAIR OF EXISTING LUMINAIRES

A. Reuse existing luminaires only where called for. Perform the following work, as required, to upgrade existing luminaire.

1. Replace faulty, leaking, or noisy ballast.
2. Replace broken, damaged, worn, or faulted lamp sockets.
3. Provide new fixture wire.
4. Provide new acrylic lens system to match existing, where existing is broken.
5. Re-lamp luminaires.
6. Completely damp clean lens and interior of luminaires.

B. If ballast has leaked, remove material deposited in fixture. Assume material was PCB contamination, or test samples to show material is not PCB and submit a report. Dispose of material as required by EPA, including clean-up materials used. Dispose of ballast which do not have non-PCB label in PCB containers and have containers taken to EPA approved incinerators. Follow all EPA regulations for transporting material.

C. New fixtures may be provided to replace existing fixtures scheduled to remain or be reused, subject to shop drawing approval.

3.05 REMOVAL OF BALLAST IN EXISTING LIGHT FIXTURES

A. Assume ballast contain PCB materials unless labeled otherwise, or test samples to show materials are not PCB; submit test report. Remove all ballast from existing light fixtures indicated on contract documents. Dispose of all ballast which do not have non-PCB labels in PCB containers and pay all costs to have containers taken to EPA approved incinerators and disposed of per all EPA regulations. Follow all EPA regulations for transporting containers and materials. If ballast has leaked in existing fixture, remove material deposited in fixture and dispose of those material as listed above. Provide Certificate of Disposal and all associated paperwork to Owner's representative.

3.06 REMOVAL OF LAMPS IN EXISTING LIGHT FIXTURES

A. Assume all fluorescent lamps contain Mercury materials unless labeled otherwise, or test samples to show materials do not contain Mercury and submit test report. Remove all lamps from existing light fixtures indicated on contract documents. Dispose of all lamps which do not have non-Mercury labels in compliance with the requirements of the New York State Department of Environmental Conservation and all applicable Federal Laws. Follow all regulations for transporting materials. Provide Certificate of Disposal and all associated paperwork to Owner's representative.

END OF SECTION

SECTION 270315 - COMMUNICATIONS CABLING SPECIAL REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract including the General and Supplementary Conditions of Division 1 of the Specification Sections, apply to the work of this section.

1.02 SUBMITTALS

A. Contractor qualifications.
B. Test report format and blank forms.
C. Complete riser diagram.
D. Test report booklets (6) copies; all failed cables shall be flagged with a tab on the test report.
E. Written certificate of completion.

1.03 CONTRACTOR'S QUALIFICATIONS

A. Installer shall certify to the Engineer's satisfaction, that they have the necessary knowledge and experience to successfully complete the specified work prior to starting any work. Contractor shall submit to Architect and/or Engineer the requirements listed below.

B. Contractors which do not meet qualifications listed will not be permitted to perform any installation work.

C. Contractor shall have on staff for the previous 12 months, prior to the bid date a Registered Communications Distribution Designer. Submit a copy of current registration information and date of original certification for RCDD.

D. Installers shall have minimum (5) years experience with computer network installations.

E. Installer shall provide to Architect/Engineer, a reference list of (10) recently completed projects of similar size and scope. Reference list shall include detailed description of installers actual work responsibilities. Reference list shall also include contact persons and telephone number for each project.

F. Submit certifications or similar documents indicating technician experience levels regarding communications and computer networking experience.

1.04 PROJECT STANDARDS

A. All equipment and installation methods shall conform to nationally recognized standards.

B. All work shall be in compliance with IEEE Standard 802.

C. All cabling and all components shall be in compliance with EIA/TIA 568, ISO9001, IEC 11801 latest revision.

D. All cabling shall utilize pair to pair and power sum testing methods.

E. Selected installation methods specified herein may include more specific requirements than listed in the above referenced standards. Contractor is instructed to comply with both minimum standards (such as listed above) and any additional items specifically required in these specification sections relating to Computer Network Cabling.

F. All Enhanced Category 6 cable connectors and terminations will comply with EIA/TIA 568, ISO9001 and IEC 11801 Standards; Type B.

1.05 ACCEPTANCE TESTING

A. General: The entire network cabling system shall be fully tested by a qualified Contractor.

B. Testing procedures shall comply with the latest versions of applicable IEEE & EIA/TIA Standards, this section, and specific requirements of other sections of this specification.

C. Architect, Engineer and Owner shall be notified (2) weeks prior to commencement of testing. All testing shall be done in the presence of the Owner's Representative or test will be rejected.

D. Required Instruments: The entire copper cabling system shall be tested with the instrument specified in these specification for the copper system. The fiber optic cabling shall be tested using an Optical Time Domain Reflectometer.

1.06 PAYMENT REQUISITION SPECIAL APPROVAL:

A. Requisition payments of 50% of Contract or $25,000 (whichever is greater) will not be released until testing results are submitted, verified and approved by engineer.

1.07 SPECIAL PROJECT DOCUMENTATION

A. Contractor shall provide individual typed booklets listing each node number and the room number in which it is located for each wiring closet. Provide (1) preliminary set of booklets to Architect/Engineer for approval. After approval provide (2) additional sets of all booklets; one copy shall be located in the corresponding wiring closet. The other complete set shall be turned over to the Owner.

1.08 TESTING REPORTS

A. Contractor shall submit written test reports for all types of cables and on each individual cable. All individual test reports shall be bound into a booklet form. Contractor shall submit (1) paper copy of final testing report to Architect/Engineer and all data on CD. For multiple buildings provide (1) copy for each building involved in project.

B. Prior to the start of work, Contractor shall submit test booklet format and blank test report forms for Engineer approval.

C. Report booklet shall include final riser diagrams with cable identification numbers.

D. Provide cover sheet per building including all nodes and associated test results. Cover sheet shall include Building Name, Wiring Closet Number, Type of Cable, Room Number, Room Name, Result (Pass or Fail), Length, etc.

E. All individual cable test result sheets shall indicate the following general information:

1. Building Name
2. Testing Company
3. Test Date
4. Type of Test
5. Software Version
6. Cable Identification Number
7. Type of Cable
8. Rack Number
9. Local Building Location
10. Operator's Signature (Testing Company)
11. Test Instrument Calibration Status
12. Witness Signature (Owner's Representative)

13. Test Instrument Set Up Values
14. Pass/Fail Indication
15. Fiber optic test report shall include the fiber strand color on each test report and fiber patch panel location for each end.

F. Copper Cable:

1. Test result sheet shall indicate, as a minimum, the following information:

2. Test results shall be listed for each individual conductor pair in each cable.

3. Individual test report swept out to 500 MHz for each reel of cable with ACR values for power sum and pair to pair ratings.

4. Cable Testing:
   a) Required Testing Instruments: all copper cable runs are to be tested by the Contractor using a Fluke # DSX2-8000; or equal.

5. Tests shall include the following:
   a) Wiremap
   b) Length
   c) Attenuation to Crosstalk (ACR) Power Sum
   d) Return Loss (RL)
   e) Near End Crosstalk (NEXT) Power Sum
   f) Equal Level Far-End Crosstalk (ELFEXT
   g) Power Sum Attenuation

6. Cable identification number, conductor pair number.

G. Fiber Optic Cable:

1. Test results shall be listed for all active and unterminated dark strands in each cable.

2. Test results shall include reflectometer (OTDR) graphical trace for entire cable length. Trace shall be magnified to largest scale possible. Testing for multi strands shall be done at both 850 and 1300 nm wave lengths. Single mode fibers shall be tested at both 1310 and 1550 nm wave lengths.

3. Light sources shall operate within the ranges of 805 ± 30 nm or 1300 ± 20 nm. Testing and instruments shall comply with EIA/TIA-526-14. Power meters shall be calibrated and traceable to the National Bureau of Standards.

H. Link Attenuation:

1. Link attenuation shall be based on the connectivity requirements of TIA/EIA-568B.1 and the use of the One Reference Jumper Method specified by ANSI/TIA/EIA-526-14-A, Method B and ANSI/TIA/EIA-526-7, Method A.1. The user should follow the procedures established by these standards to accurately conduct performance testing.

2. The reference jumper should be wrapped in five non-overlapping turns around a smooth round mandrel (rod) during the reference calibration of the source to the detector and for all loss measurements. The mandrel diameter shall be specified as in Table 11-15 of TIA/EIA-568B.1.

3. The horizontal optical fiber cabling link segments should only be tested at one wavelength. The horizontal link shall be tested at 850 nm or 1300 nm in one direction in accordance with TIA/EIA-526-14-A, Method B, One Reference Jumper. The attenuation test results shall be less than 2.0 dB.

4. The backbone optical fiber cabling link segment shall be tested in at least one direction at both operating wavelengths to account for attenuation deltas associated with wavelength. Singlemode backbone links should be tested at 1310 nm and 1550 nm in accordance with TIA/EIA-526-7 Method A.1 One Reference Jumper. Multimode backbone links shall be tested at 850 nm and 1300 nm in accordance with TIA/EIA-526-14A, Method B, One Reference Jumper. The following link attenuation equation should be used to determine acceptance values based upon the component requirements of TIA/EIA-568B.3 at each of the applicable wavelengths:
   a) Link Attenuation = Cable Attenuation + Connector Insertion Loss + Splice Insertion Loss

5. A centralized optical fiber cabling link shall be tested at 850 nm or 1300 nm in one direction in accordance with TIA/EIA-526-14A, Method B, One Reference Jumper. The attenuation results shall be less than 3.3 dB.

6. For centralized optical fiber cabling link segments implemented in conjunction with open office cabling with a consolidation point, the attenuation results shall be less than 4.1 dB.

I. Reel Testing:

1. All fiber shall be tested on original shipping reel prior to installation.

2. Perform the following tests on the installed fiber optic cable systems:

3. End to End Attenuation Test: Test and record end to end optical power loss between all termination point segments and both listed wave lengths. Test reports shall indicate wave lengths, segment power budgets, actual test values.

J. OTDR Testing:

1. Perform Optical Time Domain Reflectometer (OTDR) testing to identify attenuation and locations of individual components. OTDR shall be capable of resolving components less than 13 ft. apart.

2. Testing report shall include printed individual graphical signature traces for each strand.

3. OTDR testing shall include the following:
   a) Fiber loss at both listed wave lengths.
   b) Detect fault points (if any).
   c) Measure overall length.
   d) Splice losses.
   e) Connector losses.
   f) High resolution OTDR trace at connectors.

K. Transmitter/Receiver Level Testing: After installation of network electronics, test device transmit levels at source, then test receiver power levels at opposite end of fiber strand. Verify received power level is within operating level of network devices.

L. Certificate of Completion:

1. The Contractor shall certify in writing (6 copies), that the entire network cabling systems is 100% complete, properly installed, in full compliance with IEEE & EIA/TIA Standards, fully tested, and that all documentation has been transmitted to the Owner or his representative.

2. The certificate shall state the Contractor's warrantee for completed work.

END OF SECTION

SECTION 270350 - TESTING REPORT SUMMARY

Building: _____ Cable Type: _____

Test Date: _____ Cable Level: _____

Project #: _____ APN #: _____

Patch Panel ID: _____

Room #	Node #	Test Pass/Fail	ACR / Pair			
			1-2	3-6	4-5	7-8

END OF SECTION

SECTION 271400 - FIBER OPTIC CABLE AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including the General and Supplementary Conditions and Division 1 Specification Sections, apply to the work of this section.

1.02 WORK INCLUDED

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents

1.03 SCOPE

A. Backbone cabling includes copper and optical fiber cabling from the service entrance to the main communication rooms and cable between the main communication room and secondary communication rooms.

B. This section includes minimum requirements for the following:

1. Fiber Optic Backbone cable

1.04 QUALITY ASSURANCE

A. All cable shall be installed in a neat and workmanlike manner. 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 Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" 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 applicable requirements of:

1. ANSI/TIA/EIA – 568B.X (2000 or newer edition)
2. ANSI/TIA/EIA – 569A (1998 or newer edition)
3. NFPA 70 - 2002
4. BICSI Telecommunications Distribution Methods Manual, current edition
5. FCC 47 CFR 68
6. NEMA - 250
7. NEC - Articles 725,760, 770 and 800
8. IEEE C2 National Electrical Safety Code
9. ISO/IEC 11801
10. ANSI-J-STD-607-A
11. ANSI/TIA/EIA 606-A (2002 or current edition)
12. ANSK/NECA/BICSI 568 (2001 or current edition)

C. The optical fiber cable plant shall be used to support Gigabit and 10-Gigabit Ethernet networks.

D. If this document and any of the documents listed above are in conflict, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.

1.05 SUBMITTALS

A. Manufacturers catalog sheets, specifications and installation instructions for all cable, connecting hardware and patch cables.

B. Termination details for all cable types.

C. List of (3) installations of equivalent or larger systems that have been installed within the past (2) years and have been operating satisfactorily for a minimum of (1) year. (Include names and phone numbers of references).

D. Cable Test Reports (at substantial completion).

E. Cable tension reports for optical fiber pulls backbone pulls over 200'.

PART 2 - PRODUCTS

2.01 FIBER OPTIC CABLE

A. Cable shall be plenum rated and meet the requirements Flame Test: UL 910 (NFPA 262 1994).

B. All fibers in the cable must be usable fibers and meet required specifications.

C. All optical fibers shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification.

D. Each optical fiber shall consist of a doped silica core surrounded by a concentric glass cladding. The fiber shall be a matched clad design.

E. All optical fibers shall be proof tested by the fiber manufacturer at a minimum of 100 kpsi.

F. The fiber shall be coated with a dual layer acrylate protective coating. The coating shall be in physical contact with the cladding surface.

G. The coated fiber shall have a layer of Teflon* placed between the dual layer acrylate coating of the optical fiber and the thermoplastic buffer. The diameter of the thermoplastic buffer coating shall be 900 ± 50 *m.

H. The fiber coating and buffer shall be removable with commercially available stripping tools in a single pass.

I. The multimode fiber utilized in the cable specified herein shall be OM1 62.5 µm fiber.

J. The non-dispersion shifted single-mode fiber utilized in the cable specified herein shall conform to the following specifications:

1. Typical Core Diameter: 8.3 *m.
2. Cladding Diameter: 125.0 ± 1.0 *m.
3. Core-to-Cladding Offset: * 0.6 *m.
4. Cladding Non-Circularity: * 1.0%.
5. Coating Diameter: 245 ± 10 *m.
6. Attenuation Uniformity- No point discontinuity greater than 0.1 dB at either 1310 nm or 1550 nm.
7. Attenuation at the Water Peak- The attenuation at 1383 ± 3 nm shall not exceed 2.1 dB/km.
8. Cutoff Wavelength- The cabled fiber cutoff wavelength shall be < 1260 nm.
9. Mode Field Diameter: 9.30 ± 0.50 *m at 1310 nm, 10.50 ± 1.00 *m at 1550 nm

10. Zero Dispersion Wavelength (*o)- 1301.5 nm * *o * 1321.5 nm.
11. Zero Dispersion Slope (So)- * 0.092 ps/(nm²*km).
12. Fiber Curl: > 4.0 m radius of curvature.

K. Physical Characteristics

1. Plenum Cables up to 24 Fiber

2. The fibers may be stranded around a dielectric central member and surrounded by layered aramid yarns. The aramid yarns shall serve as the tensile strength member of the cable.

3. A ripcord shall be applied between the aramid yarns and the outer jacket to facilitate jacket removal.

4. The outer jacket shall be extruded over the aramid yarns for physical and environmental protection.

L. Plenum Cables with 24 to 72 Fibers

1. The buffered fibers shall be grouped in six fiber subunits. In each subunit, the individual fibers shall be stranded around a dielectric central member and surrounded by layered aramid yarns.

2. A ripcord shall be incorporated in the subunit design to facilitate access to the individual fibers.

3. The subunit jacket shall be extruded over the aramid yarns for additional physical and environmental protection.

4. The subunits shall be stranded around a dielectric central member.

5. A ripcord shall be inserted beneath the outer jacket to facilitate jacket removal.

6. The outer jacket shall be extruded around the units for physical and environmental protection.

M. Strength Members:

1. The strength member shall be a high modulus aramid yarn.

2. The aramid yarns shall be helically stranded around the buffered fibers.

3. A non-toxic, non-irritant talc shall be applied to the yarn to allow the yarns to be easily separated from the fibers and the jacket.

N. Cable Jacket:

1. The jacket shall be continuous, free from pinholes, splits, blisters, or other imperfections.

2. The jacket shall have a consistent uniform thickness; jackets extruded under high pressure are not acceptable.

3. The jacket shall be smooth, as is consistent with the best commercial practice.

4. The jacket shall provide the cable with a tough, flexible, protective coating, able to withstand the stresses expected in normal installation and service.

5. The cable and subunit jacket color shall be orange for cables containing multimode fibers. The cable and subunit jacket color shall be yellow for cables containing single-mode fibers.

6. For cables with more than two fibers, the cable jacket shall be designed for easy removal without damage to the optical fibers by incorporating a ripcord under each cable jacket. A non-toxic, non-irritant talc shall be applied to the aramid yarns to allow the yarns to be easily separated from the fibers and the jacket.

7. The nominal thickness of the cable outer jacket shall be sufficient to provide adequate cable protection while meeting the mechanical, flammability, and environmental test requirements of this document over the life of the cable.

O. The cable shall be all-dielectric.

P. The individual fibers shall be color coded for identification. The optical fiber color coding shall be in accordance with EIA/TIA-598, "Color Coding of Fiber Optic Cables." The coloring material shall be stable over the temperature range of the cable, shall not be susceptible to migration, and shall not affect the transmission characteristics of the optical fibers. Color coded buffered fibers shall not adhere to one another. When fibers are grouped into individual units, each unit shall be numbered on the unit jacket for identification. The number shall be repeated at regular intervals.

Q. The outer cable jacket shall be marked with the manufacturer's name or file number, date of manufacture, fiber type, flame rating, listing mark, and sequential length markings every two feet. The marking shall be in contrasting color to the cable jacket.

R. The cable shall withstand a minimum compressive load of 890 N/cm (500 lbf/in) applied uniformly over the length of the compression plate. The cable shall have an aluminum or steel interlock armor that increases the crush resistance at least ten times that of standard fiber cable, typically 89 N/cm (50 lbf/in). The cable shall be tested in accordance with FOTP-41, "Compressive Loading Resistance of Fiber Optic Cables." While under compressive load, the fibers shall not experience an attenuation change greater than 0.4 dB at 1550 nm (single-mode) or greater than 0.6 dB at 1300 nm (multimode). After the compressive load is removed, the fibers shall not experience an attenuation change greater than 0.2 dB at 1550 nm (single-mode) or greater than 0.4 dB at 1300 nm (multimode).

S. The cable shall withstand a minimum of 20 impact cycles. The cable shall be tested in accordance with FOTP-25, "Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies." The fibers shall not experience an attenuation change greater than 0.2 dB at 1550 nm (single mode) or greater than 0.4 dB at 1300 nm (multimode).

T. The cable shall withstand 25 mechanical flexing cycles at a rate of 30 ± 1 cycles per minute. The cable shall be tested in accordance with FOTP-104, "Fiber Optic Cable Cyclic Flexing Test." The fibers shall not experience an attenuation change greater than 0.2 dB at 1550 nm (single mode) or greater than 0.4 dB at 1300 nm (multimode).

U. All cables shall comply with the requirements of the National Electrical Code (NEC), Article 770. Plenum cables (OFNP and OFCP) shall pass UL-910.

V. Design Make: Corning

1. (12) Multimode 50u Armored Part Number #012T88-33190-A3
2. (12) Single-Mode Armored Part Number #012E88-33131-A3

W. Acceptable Manufacturers:

1. Corning

2. OCC
3. AMP

2.02 OPTICAL FIBER CABLE CONNECTORS

A. High-precision connectors with insert loss – 0.1 dB typical/0.5 dB maximum per connector pair for multimode, 0.2 dB typical/0.5 dB maximum per connector pair for single-mode.

B. 50u Multimode Fiber Connectivity (OM4)

1. The optical fiber field-installable connector shall be LC, for installation onto multimode a laser optimized 50-micron fiber.

2. The optical fiber field-installable connector shall be compatible with 900-micron buffered fibers.

3. The optical fiber field-installable connector shall meet or exceed the performance criteria found in ANSI/TIA-568-C.3.

4. The optical fiber field-installable connector shall have a maximum Loss of 0 .5 dB.

5. The optical fiber adapter module that occupies the faceplate shall be equipped with zirconia ceramic sleeve.

6. Laser optimized multimode fiber connector color shall be aqua.

C. Singlemode Fiber Connectivity (OS2)

1. The optical fiber field-installable connector shall be LC, for installation onto singlemode 8.3/125-micron fiber.

2. The optical fiber field-installable connector shall meet or exceed the performance criteria found in ANSI/TIA-568-C.3.

3. The optical fiber field-installable connector shall be compatible with 900-micron buffered fibers or 250-micron loose-tube fibers.

4. The preferred method of terminating loose-tube singlemode fiber is pigtail splicing into a rack mounted optical fiber panel or wall-mounted enclosure. Pigtails shall be factory terminated and 3 meters in length. A fiber enclosure with slack storage trays must be used when pigtail-splicing method is used.

5. The splice loss through each connector pair shall not exceed 0.50 dB.

6. The optical fiber adapter module that occupies the faceplate shall be equipped with zirconia ceramic sleeve.

7. Singlemode fiber connector color shall be blue.

D. Design Make: Corning Cable Systems UniCam High performance LC

E. Acceptable Manufacturers

1. AMP
2. OCC
3. Leviton

2.03 Fiber Enclosure

A. Shall be rack mounted

B. Front and rear transparent polycarbonate doors and chassis covers

C. Magnified label holders to clearly identify fiber connections

D. Shall be constructed with 16-gauge steel.

E. Housings have sliding tray (01U and 02U) or open top at front (03U and 04U)

F. Meets ANSI/TIA/EIA-568A and 606

G. 17" enclosure depth

H. Fiber management rings that are adjustable and stackable for optimized fiber slack organization

I. Mounting provisions for buffer tube fan-out kits

J. Provide LC connector housing panels as required to accommodate all fiber called for on plans.

K. Shall accommodate 24, 48, 72, 96, or 144 fibers as called for on the drawing rack elevations and drawings.

L. Design Make: Corning CCH series

PART 3 - EXECUTION

3.01 Optical Fiber

A. Bending Radius

1. Do not exceed the cable's minimum bend radius. Bending cable tighter than the minimum bend radius may result in increased optical fiber attenuation, optical fiber breakage, or the development of microfractures.

2. Nonconductive backbone optical fiber cables shall have a minimum bend radius of 10 times the cable's outside diameter when under no load and 15 times the cable's outside diameter when being pulled.

3. Conductive backbone optical fiber cables shall have a minimum bend radius of 10 times the cable's outside diameter when under no load and 20 times the cable's outside diameter when being pulled. Check manufacturer's specifications on the cable bend radius requirements.

B. Furnish Strain relief at top of vertical rise

C. Innerduct shall be provided for all interior building optical fiber cables, in a minimum of 1" diameter. Place innerduct inside EMT conduits or provide plenum rated. Place a spare pull-line in during installation of the innerduct.

D. Optical Fiber splices are not allowed. Should fiber be broken during installation the entire run shall be replaced.

E. Interior cable installed in accessible ceilings shall be installed in open top cable hangers 4 foot on center or in cable tray. Install the cables as close to the ceiling deck as possible in a segregated pathway. Do not install with UTP or coax cables.

F. Provide tie wraps to close top of cable hangers after installation is complete.

G. Exterior cable shall be installed in one of the following methods:

1. Underground ductbank

2. Inner duct across roof

3. EMT conduit for installations more than 50 feet inside building.

4. Messenger wire supported across road. Provide galvanized steel messenger and wrap spiraled around fiber and support system to even distribute fiber cable weight between distribution points.

H. Maintain polarization for entire system as described in ANSI/EIA/TIA-568-A section 12.7.1.

END OF SECTION

SECTION 27 15 00 HORIZONTAL CABLING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all General Conditions, Supplementary Conditions, Division 1 specification sections as well as Information to Bidders requirements that are included in the project documents, apply to the work of this Contract.

1.02 SCOPE OF WORK

A. Provide labor, materials, equipment, and services to perform the work required for a complete installation as required in the Contract Documents.

B. Work specified in this section is included in the cabling contract.

C. This section shall include the following:

1. Category 6 and 6A cable
2. Patch Panels
3. Communications Faceplates
4. Termination Jacks

1.03 REFERENCES

A. The products and work herein specified shall comply with the current additions of the following publications and standards.

1. UL - Underwriter Laboratory

2. NEC – National Electric Code
   a) Article 725
   b) Article 770
   c) Article 800

3. NFPA – National Fire Protection Association

4. NECA - Standard of Installation

5. ANSI – American National Standards Institute

6. NEMA – National Electrical Manufactures Association
   a) Article 250

7. EIA – Electronic Industries Alliance
   a) ANSI/TIA/EIA-568-C.2.
   b) ANSI/EIA/TIA 569B
   c) ANSI/EIA/TIA 606A
   d) ANSI-J-STD-607-A
   e) ANSI/TIA/EIA-606-A

8. TIA – Telecommunications Industry Association

9. IEEE C2 National Electrical Safety Code

10. FCC - Federal Communications Commission
    a) CFR 68

11. BICSI – Building Industry Consulting Services International
    a) Distribution Methods Manual
    b) ANSK/NECA/BICSI 568

12. ISO/IEC 11801

B. If this document and any of the documents listed above are in conflict, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.

1.04 QUALITY ASSURANCE

A. All work shall be provided in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents, shall be provided in accordance with industry standards and shall be subject to the control and approval of the Owners representative.

B. Equipment and materials shall be of the quality and manufactures indicated. The equipment specified is based on the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in everyway to that of the equipment specified, and subject to the approval of the Engineer.

C. Strictly adhere to all Category 6 (BICSI and TIA) and manufacturer recommended installation practices when installing high performance cabling.

D. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

E. The contractor shall furnish a list of three (3) installations of equivalent or larger systems that have been installed within the past two (2) years and have been operating satisfactorily for a minimum of one year. (Include names and phone numbers of references) with bid.

1.05 SUBMITTALS

A. Provide manufactures cutsheets, specifications, and installation instructions for the products herein specified.

1. Category 6 cable
2. Category 6 Patch Panels
3. Communications Faceplates
4. Wall Phone Faceplates
5. Modular Jacks

B. Termination details for all cable types.

PART 2 – PRODUCTS

2.01 CATEGORY 6 100 OHM UNSHIELDED TWISTED PAIR CABLE

A. The horizontal balanced twisted pair cable shall exceed the Category 6 transmission characteristics per issue of ANSI/TIA/EIA-568-C.2.

B. Shall be independently verified to comply with ANSI/TIA/EIA-568-C.2.

C. An ISO 9002 Certified Manufacturer shall make the cable.

D. Cable shall be UL LISTED.

E. Cable shall be plenum rated

F. Physical Characteristics:

1. Shall be CMP (plenum rated) rated and meet applicable requirements of ANSI/ICEA S-80-576 and NEC.
2. Conductor shall be 23 AWG solid bare annealed copper.
3. Outer jacket colors shall be orange for security cameras, Blue for Data or voice outlets.
4. Category marking shall be printed every one foot. Footage indicators shall also be provide on jacket.
5. The diameter of the insulated conductor shall be .023 in. maximum.
6. Shall consist of (4) 23 AWG twisted pairs.
7. Shall be suitable for the environment in which they are to be installed.
8. The color coding of pairs shall be:

Pair 1	W-BL; BL
Pair 2	W-O; 0
Pair 3	W-G; G
Pair 4	W-BR; BR

9. The ultimate breaking strength measured in accordance with ASTM D 4565 shall be 400 N minimum.
10. Cable shall withstand a bend radius of 1 inch at -20 degrees Celsius without jacket or insulation cracking.

G. Compliance:

1. ANSI/TIA-568-C.2
2. U.L. 444
3. U.L. 1666
4. NFPA 262

H. Impendence - 100 Ohm +/- 15

I. Guaranteed Performance (db/100m)

1. Cable shall exhibit a minimum NEXT of:

Frequency MHz	NEXT
1.0	84.3
4.0	75.3
10.0	69.3
16.0	66.2
20.0	64.8
31.25	61.9
62.5	57.4
100.0	54.3
200	49.8
250	48.3
400	45.3
550	43.2

2. Cable shall exhibit Minimum ELFEXT of:

Frequency MHz	ELFEXT
1.0	76.8
4.0	64.8
10.0	56.8
16.0	52.7
20.0	50.8
31.25	46.9
62.5	40.9
100.0	36.8
200	30.8
250	28.8
400	24.8
550	22.0

3. Cable shall exhibit maximum Insertion loss of:

Frequency MHz	Insertion Loss
1.0	2.0
4.0	3.7
10.0	5.9
16.0	7.4
20.0	8.3
31.25	10.5
62.5	15.1
100.0	19.3
200	28.2
250	31.8
400	41.5
550	49.7

4. Cable shall exhibit minimum ACR minimum of:

Frequency MHz	ACR
1.0	80.3
4.0	69.5
10.0	61.4
16.0	56.8
20.0	54.4
31.25	49.4
62.5	40.3
100.0	33.0
200	19.6
250	14.5
300	9.9

5. Cable shall exhibit PSNEXT minimum of:

Frequency MHz	PSNEXT
1.0	82.3
4.0	73.3
10.0	67.3
16.0	64.2
20.0	62.8
31.25	59.9
62.5	55.4
100.0	52.3
200	47.8
250	46.3
400	43.3

6. Cable shall exhibit minimum return loss:

Frequency MHz	Return Loss
1	20.0
4	23.6
10	26.0
16	26.0
20	26.0
31.25	23.6
32.5	25.0
100	22.5
200	21.0
250	20.5
400	19.5
550	18.8

J. Design Make: Belden Data Twist 3613 non bonded

2.02 CATEGORY 6 CONNECTING HARDWARE

A. Category 6 compliant modular jacks

B. Performance terminated on a 100M length of cable shall match requirements listed for Category 6 cable

C. Physical Characteristics

1. Jacks shall be 8 position un-keyed

2. Each jack shall be an individually constructed unit and shall snap mount in an industry standard keystone opening (.760” x 580”)

3. Jack housings shall be high impact 94 V-0 rated thermoplastic

4. Jacks shall have a temperature rating of -10 °C (14°F) to 60°C (140 °F) in conformance with ANSI/TIA/EIA-568-A

5. Jacks shall utilize a 2 layer printed circuit board to control NEXT

6. Jack housings shall fully encase and protect printed circuit boards and IDC fields.

7. Housing shall be ultrasonically welded for tamper resistance.

8. Modular jack contacts shall accept a minimum of 2500 mating cycles without degradation of electrical or mechanical performance.

9. Contacts will maintain a minimum vertical deflection force of 100 grams over deflection window.

10. Modular jack contact wires shall be formed flat for increased surface contact with mated plugs.

11. Contacts shall be arranged on the PC board in 2 staggered arrays, one array has 6 contacts and the other array has 2 contacts.

12. Modular jack contacts shall be constructed of Beryllium copper for maximum spring force and resilience.

13. Contact Plating shall be a minimum of 50 micro inches of hard gold in the contact area over 50 micro-inch of nickel.

14. Jack termination shall follow the industry standard 110 IDC.

15. IDC contact termination towers shall be paired and angled at 29.5 degrees.

16. IDC contacts shall be laid out in staggered arrays of 4 sets of 2 contacts.

17. Jacks shall have a designation indicating Category 6 on the nose which can be plainly seen from the front of the faceplate. Bottom of jack shall have date code and an abbreviated catalog number.

18. Jacks shall utilize a paired punch down sequence. Cable pair twists shall be maintained up to the IDC, terminating all conductors adjacent to its pair mate to better maintain pair characteristics designed by the cable manufacturer.

19. 110 IDC shall utilize 100 micro-inch tin lead plated (60% tin/40%lead) over phosphor bronze over nickel.

20. Jacks shall terminate 22-26 AWG stranded or solid conductors.

21. Jacks shall terminate insulated conductors with outside diameters up to .050”

22. Jacks shall be compatible with single conductor 110 impact termination tools.

23. Jacks shall include translucent wire retention stuffer cap, that hold terminated wires in place and allow the conductors to be visually inspected in the IDC housing.

24. Stuffer cap shall have a positive locking latch to provide conductor strain relief.

25. Stuffer cap used for wire termination with channel lock style pliers.

26. Jacks shall be compatible with TIA/EIA 606 color code labeling

27. Jacks shall accept snap on icons for identification or designation of applications.

28. Jacks shall be available in 6 colors for identification or designation of applications at the workstation or telecommunication room.

29. Jacks shall have universal wiring designation.

30. Jacks shall be marked with the T-568A wiring scheme.

31. Jacks shall have an attached color coded wiring instruction label housed between the IDC termination towers.

32. Jacks shall be manufactured in the USA

33. Jacks shall be designed for 100 Ohm UTP cable termination

34. Jacks shall be UL LISTED 1863 and CSA certified.

35. Jacks shall be made by an ISO 9002 Certified Manufacturer.

D. Design Make: Belden Cat6+

E. Acceptable Manufacturers:

1. Panduit
2. Amp
3. Hubbell

2.03 CATEGORY 6A (625MHZ) 4-PAIR UNSHIELDED TWISTED PAIR CABLE

A. The horizontal balanced twisted pair cable shall exceed the Category 6A transmission characteristics per issue of ANSI/TIA/EIA 568-C.2 Category 6A. Tested to 625MHz.

B. Shall be comply with the following:

1. Category 6A - TIA 568.C.2
2. ISO/IEC 11801 ed 2.1 (2008) Class EA

C. An ISO 9002 Certified Manufacturer shall make the cable.

D. Cable shall be UL LISTED.

E. Physical Characteristics:

1. Cable shall be plenum rated and meet NFPA 262 Plenum Flame Test (UL910)(FT6).

2. Conductor shall be 23 AWG solid bare annealed copper.

3. Nominal Outside Diameter - 0.269 in.

4. Minimum Bend Radius/Minor Axis: 1.200 in.

5. Minimum Bend/Installation: 2.7 in.

6. Maximum Pulling Tension - 40 lbs.

7. Category marking shall be printed every one foot. Footage indicators shall also be provided on jacket.

8. The color coding of pairs shall be:
   a) Pair 1 White/Blue Stripe & Blue
   b) Pair 2 White/Orange Stripe & Orange
   c) Pair 3 White/Green Stripe & Green
   d) Pair 4 White/Brown Stripe & Brown

F. Electrical Characteristics Overall

1. Capacitance (pF/ft) – 17.00
2. Nominal Velocity of Propagation: 68.00%
3. Maximum Delay (ns/100 m) - 537 @ 100MHz
4. Typical Delay Skew (ns/ft)- 35
5. Maximum Delay Skew (ns/100 m) – 45
6. Maximum Conductor DC Resistance @ 20°C (Ohm/100 m) – 7.4
7. Maximum Operating Voltage - UL: 300 V RMS
8. Maximum DCR Unbalanced @ 20°C (%) : 3.000

Electrical Characteristics (Continued)

Frequency (MHz)	Input (Unfitted) Imp. (Ohms)	Fitted Impedance	Min. PSACRF (dB)
1	100+/- 15	100+/- 10	68.8
4	100+/- 15	100+/- 10	56.8
8	100+/- 15	100+/- 10	50.7
10	100+/- 15	100+/- 10	48.8
16	100+/- 15	100+/- 10	44.7
20	100+/- 15	100+/- 10	42.8
25	100+/- 15	100+/- 10	40.8
31.25	100+/- 15	100+/- 10	38.9
62.5	100+/- 15	100+/- 10	32.9
100	100+/- 15	100+/- 10	28.8
200	100+/- 22	100+/- 10	22.8
250	100+/- 22	100+/- 10	20.8
300	100+/- 22	100+/- 10	19.3
350	100+/- 22	100+/- 10	17.9
400	100+/- 22	100+/- 10	16.8
450	100+/- 22	100+/- 10	15.7
500	100+/- 22	100+/- 10	14.8
550	100+/- 22	100+/- 10	14.0
600	100+/- 22	100+/- 10	13.2
625	100+/- 22	100+/- 10	12.9
750			11.3
860			10.1

Frequency (MHz)	Min. PSANEXT (dB)	Min. PSAACRF (dB)	Min. TCL (dB)	Min. ELTCTL (dB)
1.000	67.000	67.100	40.000	35.000
4.000	67.000	67.100	40.000	23.000
8.000	67.000	61.100	40.000	16.900
10.000	67.000	59.200	40.000	15.000
16.000	67.000	55.100	38.000	10.900
20.000	67.000	53.200	37.000	9.000
25.000	67.000	51.200	32.000	7.000
31.250	67.000	49.300	35.100	
62.500	66.600	43.300	32.000	
100.000	63.500	39.200	30.300	
200.000	59.000	33.200	27.000	
250.000	57.500	31.200	26.000	
300.000	56.300	29.700	25.200	
350.000	55.300	28.300	24.600	
400.000	54.500	27.200	24.000	
450.000	53.700	26.100	23.500	
500.000	53.000	25.200	23.000	
550.000	52.400	24.400		
600.000	51.800	23.600		
625.000	51.600	23.300		
750.000	50.400	21.700		
860.000	49.500	20.500		

Frequency (MHz)	Max. Attentuation (dB/100 m)	Min. PSNEXT (dB)	Min. PSACR (dB)	Min. RL (dB)
1	2.100	73.3	71.2	20.000
4	3.800	64.3	60.5	23.000
8	5.300	59.8	54.4	24.500
10	5.900	58.3	52.4	25.000
16	7.500	55.2	47.8	25.000
20	8.400	53.8	45.4	25.000
25	9.400	52.3	43	24.300
31.25	10.500	50.9	40.4	23.600
62.5	15.000	46.4	31.4	21.500
100	19.100	43.3	24.2	20.100
200	27.600	38.8	11.2	18.000
250	31.100	37.3	6.3	17.300
300	34.300	36.1	1.9	16.800
350	37.200	35.1		16.300
400	40.100	34.3		15.900
450	42.700	33.5		15.500
500	45.300	32.8		15.200
550	47.700	32.2		14.900
600	50.100	31.6		14.700
625	51.200	31.4		14.500
750	56.700	30.2		14.000
860	61.200	29.3		13.600

G. Applications

1. 10GBASE-T Full Power Implementation (IEEE 802.3an).

2. 10GBASE-T Low Power Implementation (Short Reach Mode) (IEEE 802.3an).

3. 1000BASE-T Applications (IEEE 802.3ab).

4. Power Over Ethernet Plus - 2 pairs, up to 30 Watts or 4-pairs, up to 60 Watts (IEEE 802.3at).

5. Power Over Ethernet - 2 pairs, up to 12.95 Watts (IEEE 802.3af).

6. Broadband Video (CATV) & High-Speed Internet (DOCSIS) over UTP up to 860 MHz.

7. High Temperature performance up to 50°C without length de-rating for 1000BASE-T and 100BASE-TX.

H. Design Make: Belden 10GXS13

I. Acceptable Manufacturers:

1. Commscope
2. Berktek
3. Amp

2.04 CATEGORY 6A MODULAR JACKS

A. ETL - Verified Category 6A

B. Performance terminated on a 100M length of cable shall match requirements listed for Category 6A cable

C. Physical Characteristics:

1. Color as determined by owner and matching attached cable color. Provide different colors for each of the following:
   a) Wireless Access Points
   b) Desktop Data and VoIP
   c) Security
   d) Wall mounted VoIP

2. Front Connection Flexible PCB with 50u inch Gold over Nickel.

3. Rear Connection IDC Phosphor Bronze with Tin Plating over Nickel.

4. Connector Body N/A Plastic - UL940V-0

D. Mechanical Characteristics:

1. Footprint/Type: KeyConnect
2. Plug / Jack Compatibility: RJ45,
3. Cable/Connector Retention: 15 lbs.

E. Standards Compliance:

1. FCC Part 68, Subpart F
2. IEC 60603-7
3. ISO/IEC 11801:2002 Amendment 2
4. ACA, Bi-national Standard Listed

F. Electrical Characteristics:

Frequency (MHz)	Max. Insertion Loss TIA* (dB)	Max. Insertion Loss Belden** (dB)	Min. NEXT TIA* (dB)	Min. NEXT Belden** (dB)	Min. FEXT TIA* (dB)	Min. FEXT Belden** (dB)
1.000	0.100	0.050	75.000	77.000	75.000	80.000
4.000	0.100	0.050	75.000	77.000	71.100	75.100
8.000	0.100	0.050	75.000	77.000	65.000	69.000
10.000	0.100	0.050	74.000	77.000	63.100	67.100
16.000	0.100	0.060	69.900	72.900	59.000	63.000
20.000	0.100	0.070	68.000	71.000	57.100	61.100
25.000	0.100	0.080	66.000	69.000	55.100	59.100
31.250	0.110	0.090	64.100	67.100	53.200	57.200
62.500	0.160	0.140	58.100	61.100	47.200	51.200
100.000	0.200	0.180	54.000	57.000	43.100	47.100
200.000	0.280	0.260	48.000	51.000	37.100	41.100
250.000	0.320	0.300	46.000	49.000	35.100	39.100
300.000	0.350	0.330	42.900	46.700	33.600	37.600
400.000	0.400	0.380	37.900	42.900	31.100	35.100
500.000	0.450	0.430	34.000	40.000	29.100	33.100
625.000		0.480		37.100		31.200
Mated Connection Table - Footnote: *TIA/EIA-568-B.2-10-2008 Category 6A Standard.						
****Worst-case performance for a 10GX mated connection using 10GX modular plugs.**						

Frequency (MHz)	Max. Return Loss TIA* (dB)	Max. Return Loss Belden** (dB)	Min. PSANEXT TIA* (dB)	Min. PSANEXT Belden** (dB)	Min. PSAACRF TIA* (dB)	Min. PSAACRF Belden** (dB)	Min. Balanced TCL TIA* (dB)	Min. Balanced TCL Belden** (dB)
1.000	30.000	34.100	70.500	72.000	67.000	72.000	40.000	45.000
4.000	30.000	34.100	70.500	72.000	67.000	72.000	40.000	45.000
8.000	30.000	34.100	70.500	72.000	67.000	72.000	40.000	45.000
10.000	30.000	34.100	70.500	72.000	67.000	72.000	40.000	45.000
16.000	30.000	34.100	70.500	72.000	67.000	72.000	40.000	45.000
20.000	30.000	34.100	70.500	72.000	67.000	72.000	40.000	45.000
25.000	30.000	34.100	70.500	72.000	67.000	72.000	40.000	45.000
31.250	30.000	34.100	70.500	72.000	67.000	72.000	38.100	45.000
62.500	30.000	34.100	70.500	72.000	67.000	72.000	32.100	39.100
100.000	28.000	30.000	70.500	72.000	67.000	72.000	28.000	35.000
200.000	22.000	24.000	64.500	66.000	61.000	66.000	22.000	29.000
250.000	20.000	22.000	62.500	64.000	59.000	64.000	20.000	27.000
300.000	18.500	20.500	61.000	62.500	57.500	62.500	18.500	25.500
400.000	16.000	18.000	58.500	60.000	55.000	60.000	16.000	23.000
500.000	14.000	16.000	56.500	58.000	53.000	58.000	14.000	21.000
625.000		13.000		56.100		56.100		19.100
Dielectric Strength: 1,000 V RMS @ 60 Hz for 1 minute								
Current Rating: 1.500 A								
Insulation Resistance: 50 M-Ohm Minimum								
Max. Contact Rsitance: 20 m-Ohm								
Termination Resistance: 2.5 m -OHM								

G. Design Make: Belden 10GX Modular Jack, Category 6A, RJ45, Key Connect style.

H. Acceptable Manufacturers:

1. Commscope
2. Berktek
3. Amp

2.05 CATEGORY 6A UTP PATCH PANELS

A. Characteristics:

1. Steel housing
2. 24 or 48 ports as required by the installation
3. Shall be Blank modular panels to accept snap in RJ-45 COLOR CODED jacks as specified in this specification, color to match the attached data cable.
4. Plug / Jack Compatibility - RJ45
5. Refer to modular jack specification for transmission Characteristics.

B. Standards:

1. FCC Part 68, Subpart F, IEC 60603-7
2. ISO/IEC 11801:2002 Amendment 2

C. Design Make: Belden 10GX Patch Panel - KeyConnect

D. Acceptable Manufacturers:

1. Commscope
2. Berktek
3. Amp

2.06 FACE PLATES

A. Provide angled entry faceplates low profile and strain relief.

B. Configured to fit standard single gang outlet box.

C. Accepts all IC107 modules.

D. Rugged and durable ABS plastic construction.

E. UL listed.

F. Acceptable Manufacturers:

1. ICC
2. Belden
3. Panduit

2.07 CABLE IDENTIFICATION:

A. All cables terminated in classrooms and wiring closets shall be identified with laser wire markers. Wire markers shall be factory printed on vinyl cloth or film with a self adhesive, self-laminating wrap or permanent locking cable tie. Wrap type markers shall be minimum 1-1/2" long.

B. Contractor shall submit to Engineer product data and samples of wire markers intended for use on this project.

C. Cable identification shall be 6 digit numbers corresponding to wiring closet, patch panel, port number and drop number, refer to Drawing Legend.

D. Furnish Laser Printable Labels (PLL) with lamination Panduit Co.; or equal.

E. Identification numbers hand written by marking pen directly on cable jacket are not acceptable!!!

F. Wrap type markers shall be completely wrapped around cable OD. Application of markers using "tabbed" or "flagged" methods are not acceptable.

PART 3 - INSTALLATION

3.01 GENERAL

A. Firestop conduit openings after the cable installation is complete.

B. Separation from Electromagnetic Interference

Condition	Minimum Separation Distance
Unshielded power lines or electrical equipment in proximity to open or nonmetal pathways.	610 mm (24 in)
Unshielded power lines or electrical equipment in proximity to a grounded metal conduit pathway.	305 mm (12 in)
Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a grounded metal pathway.	152 mm (6 in)
Electrical motors and transformers.	1194 mm (47 in)

C. Installing cables above suspended ceilings

1. Pull or place cables into the zone pathway.

2. Leave sufficient slack in the ceiling to reach any telecommunications outlet/connector within the zone.

3. Where zone pathways are not provided, divide the floor area into direct-run telecommunications zones.

4. Run all the cables to the center point of their zones.

5. From the center point of each zone, distribute the cables to work areas within that zone.

6. At the center point of each telecommunications zone, support all cables with a cable tie or similar device. Tightly cinched cable ties may have a detrimental effect on transmission performance and should be avoided.

7. Coil in a figure eight any cable that is not in service back to the end of the zone pathway. When required, cable-tie these coiled cables.

8. Label the cables and pathways for easy recognition and establish a working database for ongoing identification and maintenance of horizontal cables and pathways.

9. If a J-hook or trapeze system is used to support cable bundles all horizontal cables shall be supported at a maximum of 48 inch intervals. At no point shall cable(s) rest on acoustic ceiling grids or panels.

D. Cable raceways shall not be filled greater than the ANSI/TIA/EIA-569-B maximum fill for the particular raceway type.

E. Riser rated cable shall be installed in metallic conduit when installed in a plenum space.

F. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-C.2 document, manufacturer's recommendations and best industry practices.

3.02 UTP CABLE

A. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-C.2 document, manufacturer's recommendations and best industry practices.

B. All wiring concealed in new walls or soffits shall be installed in metal conduits.

C. Wiring in existing walls with hollow cavities may be installed loose.

D. All exposed wiring shall be installed in surface metal raceway.

E. All wiring above ceilings shall be installed in cable tray or open top cable hangers and brackets.

F. Cable hangers above accessible ceilings shall be installed 4' on center attached to building structure. If cables have more than 12” of sag, install more hangers.

G. Do not untwist cable pairs more than 0.5 in. when terminating.

H. The Contractor shall be responsible for replacing all cables that do not pass required bandwidth and throughput tests.

I. Maximum length shall be 90 meters. (295 ft).

J. Maximum patch cable shall be 5 meters (16 ft).

K. Provide 10 ft service loop in the communications equipment room. Provide 3 foot service loop in ceiling above outlet. Slack should not be stored in bundled loops. Cable loops have had a degrading effect on cabling performance. Cable slack should be stored in an extended loop or in a figure-eight configuration to alleviate stress.

L. Cable shall have no physical defects such as cuts, tears or bulges in the outer jacket. Cables with defects shall be replaced.

M. Install cable in neat and workmanlike manner. Neatly bundle and tie all cable in closets. Leave sufficient cable for 90o sweeps at all vertical drops.

N. Do not tie-rap cable to a perpendicular support. Tie-raps shall be used to secure cables to other like cables or to an approved tie mount. Do not over tighten cable ties.

O. Install category 6 cable in a separate open cable hanger segment. Do not install with coaxial, optical fiber cable or any other cable type. If cables have more than 12” of sag, install more hangers.

P. Do not install UTP cable with more than 110N (25 lbs) pull force, as specified in EIA/TIA and BICSII TDDM practices. Utilize appropriate cable lubricant in sufficient quantity to reduce pulling friction to acceptable levels on: long pulls inside conduit, pulls of multiple cables into a single small bore conduit, on conduit runs greater than 100 lineal feet with bends of opposing directions, and in conduit runs that exceed 180 degrees of accumulated bends. Use of tensile rated cords (i.e. fishing line) should be used for difficult or questionable pulls - to judge to go/no-go condition of the conduit and pulling setup.

Q. Care must be taken so that the cable does not bend at any location to a radius less than ten times the diameter of the cable. A cable feeder guide of suitable dimensions should be used between the cable reel and the face of the duct to protect the cable and guide it into the duct as it is payed off the reel.

R. As the cable is payed off the reel, it should be carefully watched and inspected for sheath defects. If defects are noticed, the pulling operation should be stopped immediately and the Engineer promptly notified of the defect. Kinks and/or other irregularities in the cable sheath should be removed or corrected as directed by the engineer.

S. A plastic or nylon pull cord with a minimum test rating of 90 Kg (200 lb.) shall be co-installed with all cable installed in any conduit.

T. Horizontal distribution cables shall be bundled in groups of no more than 50 cables. Cable bundle quantities in excess of 50 cables may cause deformation of the bottom cables within the bundle and degrade cable performance.

U. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.

V. Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, the Contractor shall install appropriate carriers to support the cabling.

W. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the Contractor prior to final acceptance at no cost to the Owner.

X. Leave a minimum of 12" of slack for twisted pair cables at the outlet. Cables shall be coiled in the in-wall box, surface-mount box or modular furniture raceway if adequate space is present to house the cable coil without exceeding the manufacturers bend radius. In hollow-wall installations where box-eliminators are used, excess wire can be stored in the wall. Excess slack shall be loosely coiled and stored in the ceiling above each drop location when there is not enough space present in the outlet box to store slack cable.

Y. Cables shall be neatly bundled and dressed to their respective termination device. Each terminating device shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.

Z. Each cable shall be clearly labeled on the cable jacket behind the termination device at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

3.03 UTP MODULAR JACKS

A. All cables shall be terminated with modular jacks that snap into a faceplate mounted on a wall outlet box, surface raceways or power pole.

B. Outlet boxes shall be secured to building with mechanical fasteners. Adhesive fasteners are not allowed.

C. Jacks shall be installed to provide minimal signal impairment by preserving wire pair twists as close as possible to the point of mechanical termination. The amount of untwisted in a pair as a result of termination to the jack shall be no greater than 0.5 inches (13mm).

D. Jacks shall be installed according to manufacturer's instructions and properly mounted in plates, frames, housings or other appropriate mounting device.

E. Jacks shall be installed such that cables terminated to the jacks maintain minimum bend radius of at least 4 times the cable diameter into the IDC contacts. Cables shall be terminated on jacks such that there is no tension on the conductors in the termination contacts.

F. All extra openings to be filled with blank inserts.

G. Terminate cable per EIA/TIA T-568B standard pin assignments.

H. Remove only as much cable jacket as is required for termination and trimming. Follow the manufacturer's instructions for mounting, termination, and cable management. Minimize the amount of untwisting in a pair as a result of termination to connecting hardware. For untwisting cabling, maintain pair twists as close as possible to the termination point. The amount of untwisting must not exceed 12.7 mm (0.5 in) for category 5e and higher cables.

3.04 TESTING

A. Refer to Section 271600.

3.05 COMPLETION AND ACCEPTANCE

A. In all spaces that have had floor or wall penetrations, hammer drilling, or core boring activities - a through brooming, vacuuming, and wet mopping/sponging shall be preformed. Cleaning shall include floors, walls, ladder trays, tops of cabinets/racks, existing/new passive and active components, per manufacturer recommendations.

B. Submit copies of the following:

1. Cable Test Reports (at substantial completion).

3.06 PATCH PANELS.

A. Panels shall be installed to provide minimal signal impairment by preserving wire pair twists as closely as possible to the point of mechanical termination. The amount of untwisting in a pair as a result of termination to the patch panel shall be no greater than 0.5 inches (13 mm).

B. Panels shall be installed according to manufacturer's instructions and properly mounted to a rack, cabinet, bracket or other appropriate mounting device.

C. Panels shall be installed such that cables terminated to the panel can maintain minimum bend radius of at least 4 times the cable diameter into the IDC contacts.

D. Cables shall be terminated on the panels such that there is no tension on the conductors in the termination contacts. Panels shall be properly labeled on front and back with the cable number and port connections for each port, as per cable schedule drawings.

E. All cables shall be neatly “dressed out” in equipment rooms. Cables to be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.

F. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within a bundle, where the label is obscured from view shall not be acceptable.

G. Install factory supplied patch panel labels, in the corresponding T568B configuration, in all UTP patch panels, BEFORE beginning to terminate cables. Cables terminated onto a patch panel without said port label strip shall not be acceptable.

H. The cable jacket shall be maintained as close as possible to the termination point.

3.07 COLOR CODING

A. Prior to submitting cable and connector cuts for approval confirm with the owners IT director the required cable and jack colors.

3.08 CEILING TILES

A. The cabling contractor shall replace all ceiling tiles that are damaged due to cable installation. Tiles shall match the existing.

B. Prior to beginning work walk the proposed cable routes and document any existing damage with the construction manager.

3.09 ATTACHMENT CABLES:

A. Attachment cable assemblies, for use between workstation and room data connector, attenuation requirements ANSI/TIA/ EIA-568A, ISO9001, ISO/IEC 11081. Cables shall be Category 6, 24 AWG stranded conductors, #RJ45 connectors at each end.

B. Contractor shall furnish (1) attachment cable for each room data drop, cable length shall be as noted below unless noted otherwise on Drawings.

	Length
Classroom (Standard Rm.)	14'-0"
Computer Classroom	14'-0"
Library	14'-0"
Office/Administrative Areas	7'-0"

Note: Provide any additional attachment cables with strain relief boots for completion. Refer to Technology Room Layouts on Contract Drawings for quantity and length required.

3.10 CABLE IDENTIFICATION:

A. All cables terminated in classrooms and wiring closets shall be identified with laser wire markers. Wire markers shall be factory printed on vinyl cloth or film with a self-adhesive, self-laminating wrap or permanent locking cable tie. Wrap type markers shall be minimum 1-1/2" long.

B. Contractor shall submit to Engineer product data and samples of wire markers intended for use on this project.

C. Cable identification shall be 6 digit numbers corresponding to wiring closet, patch panel, port number and drop number, refer to Drawing Legend.

D. Furnish Laser Printable Labels (PLL) with lamination Panduit Co.; or equal.

E. Identification numbers hand written by marking pen directly on cable jacket are not acceptable!!!

F. Wrap type markers shall be completely wrapped around cable OD. Application of markers using "tabbed" or "flagged" methods are not acceptable.

END OF SECTION

SECTION 275116 – PUBLIC ADDRESS SYSTEM RENOVATIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections apply to work in this section.

1.02 WORK INCLUDED

A. Provide labor, materials, equipment, and services to perform operations required for the complete installation and related Work as required in Contract Documents.

1.03 GENERAL REQUIREMENTS

A. Provide modifications and wiring required to connect to the existing Rauland Telecenter Public Address System. Open Systems Metro Contact – George Aloia (914) 241-0057.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years experience.

B. Supplier Qualifications: Authorized distributor of specified manufacturer with minimum three years documented experience.

C. Installer Qualifications: Company specializing in installing the products specified in this section with minimum three years experience.

D. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.05 SYSTEM DESCRIPTION

A. Prior to beginning work, review the existing sequence of operation. The existing sequence of operation shall be maintained.

1.06 SUBMITTALS

A. Provide submittals for the entire system including:

1. Provide a complete system test report of the existing system by a technician certified by the system manufacturer. Submittal shall include report for owner’s reference.

2. Complete equipment list including quantities.

3. Riser Wiring Diagram showing all existing and new devices, wire quantities and sizes.

PART 2 - PRODUCTS

2.01 PUBLIC ADDRESS SYSTEM

A. Provide all modifications, speakers, wiring, volume control switches, splice boxes and additional expansion cards as required for a fully functional Public Address System.

B. Provide all programming as required for installation of new devices.

C. System circuits shall be configured to match existing system.

PART 3 - EXECUTION

3.01 GENERAL

A. Open wiring is permitted above corridors where ceiling are accessible using removable ceiling tiles. Provide conduit runouts from all outlets or wiring in non-accessible locations. Provide bushings on all conduit ends.

B. Support wiring from existing walls or ceilings using onidal rings spaced not more than 4'-0" apart. Cable laid on ceiling panels is not acceptable.

C. Wiring shall be in accordance with the recommendation of the existing sound system manufacturer.

D. Each cable shall be clearly labeled with factory printed panduit type wire markers for circuit wire number at both ends. Hand written tags will not be acceptable.

E. Each cable shall be continuous from the main control console to termination point, except where otherwise noted. Splices in wire or cable are allowed only where specifically noted.

F. Where it is impracticable to conceal conduit in finished spaces, cable shall be run in Wiremold.

3.02 TESTING

A. Each speaker shall be adjusted to provide a clear audible level of sound in all areas of the space they are intended to cover. Any defective speaker shall be replaced. No audible static shall be present on any line.

B. Submit results on an approved test report form signed by the manufacturer's representative.

C. Certificate: The manufacturer’s representative shall examine this installation and certify that the system is properly installed and operating.

END OF SECTION

SECTION 275313 - MASTER CLOCK SYSTEM - WIRELESS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract including the General and Supplementary Conditions and Division 1 Specifications Sections apply to the work of this section.

1.02 SUBMITTALS

A. Schedule of all equipment and services supplied.

B. Name, address and phone number of nearest fully equipped service organization.

C. Submit complete catalog data for each component, describing physical characteristics and method of installation. Submit brochure showing available colors and finishes of clocks.

D. Submit evidence of application for operating license prior to installing equipment. Furnish the license, or if the license has not been received, a copy of the application for the license, to the Owner prior to operating the equipment. When license is received, deliver original license to Owner.

E. Submit one clock for approval. Approved sample shall be tagged and shall be installed in the work at location directed.

F. Submit manufacturer's complete installation, set-up and maintenance instructions.

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer: Company specializing in manufacturing commercial time systems with a minimum of 10 continuous years of documented experience.

2. Installer: Company with documented experience in the installation of commercial time systems.

1.04 PROJECT SITE CONDITIONS

A. Clocks shall not be installed until painting and other finish work in each room is complete.

B. Coordinate installation of GPS receiver for access to the roof or exterior side wall so that the bracket and related fasteners are watertight.

1.05 SYSTEM DESCRIPTION

A. GPS Definition: Global Positioning System, a worldwide system that employs (24) satellites in an integrated network to determine geographic location anywhere in the world, and which employs and transmits atomic time, the most accurate and reliable time.

B. Clock system shall continually synchronize clocks throughout the facility and shall be capable of clock readouts in multiple time zones where desired.

C. Time system shall be a synchronized master-satellite time system. The system shall synchronize all clocks to each other. The system shall utilize GPS technology to provide atomic time. The system shall not require hard wiring. Clocks shall automatically adjust for Daylight Savings Time.

D. Clocks shall be synchronized to within 10 milliseconds (6) times per day, and the system shall have an internal oscillator that maintains plus or minus one second per day between synchronizations, so that clock accuracy shall not exceed plus or minus 0.2 seconds.

E. The system shall include an internal clock so that failure of the GPS signal shall not cause the clocks to fail in indicating time.

F. The system shall incorporate a fail-safe design so that failure of any component shall not cause failure of the system. Upon restoration of power or repair of failed component, the system shall resume normal operation without the need to reset the system or any component thereof.

G. Clock locations shall be as indicated, and clocks shall be fully portable, capable of being relocated at any time.

H. For substitutions offering frequency hopping technology provide Category 6 Data cabling from Master Clock System to MDF/IDF-1. Terminate on existing patch panel.

1.06 FCC LICENSING

A. Contractor shall obtain and prepare all forms necessary for licensing clock system with the FCC.

B. Contractor shall obtain signatures from District and apply to FCC upon receipt. Contractor shall present approved license and applicable paperwork to District.

C. First licensing period (prepared by Contractor) is for 10-year length.

D. Contractor shall include in their Bid contractor’s payment of all initial licensing fees.

E. District is responsible for future license renewals for subsequent 10-year periods.

1.07 REGULATORY REQUIREMENTS

A. Equipment and components furnished shall be of manufacturer's latest model.

B. Transmitter and receiver shall comply with Part 90 of FCC rules, as follows:

1. The equipment shall not cause harmful interference.

2. The equipment shall accept interference that will cause adverse on equipment operation.

3. Transmitter frequency shall be governed by FCC Part 90.35.

4. Transmitter output power shall be governed by FCC Part 90.257 (b).

C. System shall be installed in compliance with local and state authorities having jurisdiction.

D. Cost of customer owned frequency shall be included in the contract.

PART 2 - PRODUCTS

2.01 EQUIPMENT

A. The time system shall include a transmitter, roof mounted GPS receiver, indicating clocks, and all accessories for complete operation. Master-Satellite Time System shall be manufactured by Primex Wireless, Inc.

B. Wireless Clock Master Transmitter (WCMT): Model #14000 wireless transmitter with GPS receiver. Unit shall obtain current atomic time from satellite. The clock system shall transmit time continuously to all clocks in the system.

1. Transmitter shall contain an internal clock such that failure of reception from the GPS will not disable the operation of the clocks.

2. One-year warranty shall be provided on all parts.

3. Schedule of Transmitter Features:
   a) Frequency Range: One watt at frequency of 72.100 to 72.400 MHz.
   b) Transmission Range: One-mile, open field.
   c) Radio technology: Narrowband FM
   d) Number of channels: 16 user selectable
   e) Channel bandwidth: 20 kHz maximum
   f) Transition mode: One-way communication
   g) Data rate: 2 KBps
   h) Output power: 1.0 Watt
   i) Frequency: 74 MHz; ±4 kHz
   j) Power requirements: 120 VAC 60 Hz
   k) Operating range: 0°C to 70°C.
   l) Housing: black metal case, size 16-3/4"x12"x1-7/8". Furnish with wall mount shelf Model #14005.

4. Transmitter shall have the following switches:
   a) Time zone adjustment switches for all time zones in the world. Includes all US time zones: Eastern, Central, Mountain, Pacific, Alaska and Hawaii.

   b) Daylight Saving Time bypass switch.

   c) 12-hour or 24-hour display.

5. Antenna shall be 46" high, commercial type, mounted on top center of transmitter housing. Antenna gain shall be >110 dBm. Antenna polarization shall be data logic, 0 to 5 volts.

6. Transmitter housing shall incorporate a display which shall include the following:
   a) Time readout
   b) AM and PM indicator if 12-hour time display is set
   c) Day and date readout
   d) Indicator for daylight savings or standard time
   e) LED which shall flash red in event of reception problem
   f) GPS reception indicator

7. Power Supply: Model Q11666; Input: 120-volt AC 50/60 Hz, 0.4 amp; Output: 9 volt DC, 1.5 amp.

C. GPS Satellite Receiver (WCSR): (Supplied with transmitter.) Roof mounted GPS receiver including antenna in a waterproof case, 3-7/8"x4-3/16"x2", and temp. range (-32°F-158°F). Furnish with roof mounting bracket and 100 ft. cable with end connectors. Exterior cable shall be UV resistant with weatherproof insulation. Contractor shall field verify actual cable length required.

D. Wireless Tone Generator (WCTG): Model #14480. Interface to existing PA systems to synchronize wireless clocks and PA time tone. Furnish with event scheduler software, wireless data transceivers and all interface cables. Event software shall run on Owner's desktop computer.

E. Clocks:

1. General Requirements:
   a) Clocks shall automatically update time (6) times/day and shall automatically adjust daylight savings time; a user selectable disable switch shall be provided.

   b) Clocks shall have ride thru power to keep time while batteries are changed. If loss of signal occurs, clock will continue to function with quartz time until restoration of wireless signal.

   c) Receivers shall include integral internal antenna with –7 dB gain and >-110 dBm sensitivity.

2. Analog Clocks: Analog clocks shall have high impact polycarbonate frame and lens, white face, traditional dial, black hour and minute hands, red sweep second hand. Frame shall include tamperproof specialty hanger “clock lock” mounting slots.

Usage	Standard (1)	Assembly (2)
Model #	14155	14163
Type	Analog	Analog
Size	12.5” diameter	16” diameter
Mounting	Wall	Wall
Face	Single Side	Single Side
Color (Frame)	Black	Black
Power	(2) D Cell Batteries	(2) D Cell Batteries
Battery Life	5 Years	5 Years

Notes:
(1) Standard locations include: all classrooms, offices, student occupied spaces, administrative areas, prep rooms, work rooms, kitchen, etc.
(2) Assembly spaces include: cafeteria, library, gymnasiums, pool, auditorium, etc.

3. Attic Stock:
   a) High School: Furnish (15) 12.5” diameter Wireless Clocks with their associated batteries to the owner.

   b) Hillcrest: Furnish (5) 12.5” diameter Wireless Clocks with their associated batteries to the owner.

1.08 ACCESSORIES

A. Wire Guards (WG): Provide wire guard size to match clocks in gymnasiums, locker rooms and as noted on Contract Drawings.

Clock Size	12.5”	16”
Model	14131	14123
Wire Guard Size	14x14	18x18

B. Roof Mount (For Satellite Receiver): Non-penetrating roof mount, steel frame, 1.25” OD mast 60” high with painted finish. Provide roof protection pad sized to overlap frame by minimum 12” all sides. Contractor shall provide concrete blocks ballast. Lashen Electronics Co. Model #FRM-125; or equal.

C. Exterior Wall Mount: Provide 2.25” mast DBS pipe 60” length and (2) heavy duty wall bracket 6” offset with “U” bolt clamps. Furnish with all required hardware. Lashen Electronics Co. Model #WB-6; or equal.

1.09 SEQUENCE OF OPERATION

A. Transmitter Operation: When power is first applied to the transmitter, it checks for and displays the software version, then it checks the position of the switches and stores their position in memory. The transmitter then looks for the GPS time signal. Once the transmitter has received the GPS time, it sets its internal clock to that time. The transmitter then starts to transmit its internal time once every second. The transmitter updates its internal clock every time it receives valid time data from the GPS.

B. Analog Clock Operation: When the batteries are inserted into the clock; 1] Press the red button when the red second hard is at the 12:00 position. At this time the microprocessor will lock in the location of the second hand. 2] After the red second hand has passed over the minute hand (first second hash mark after minute hand), press and release the red button. At this time the microprocessor will lock in the location of the minute hand. The microprocessor then assumes the location of the hour hand.

C. After the red button has been pressed twice, the microprocessor will start searching the channels. It will start at channel #1 and proceed one by one until it either decodes a valid signal or reaches channel #16. If no signal is detected, the receiver will be shut off and try again later. If a signal is received, the microprocessor will store the channel number, set the clock to the receive time, then for the next minute the clock will beep once a second. If the clock beeps every few seconds, the clock is in marginal signal area. Clocks should operate in marginal signal areas, but battery life will be about 25% shorter.

D. After initial set, the clock will shut off the receiver. On a pre-scheduled basis, the microprocessor will turn the receiver back on and starting with the stored channel, it will again look for a valid time signal. However, the beeper will not operate.

E. If the clock has not decoded a valid time signal for seven days, then it will go back to a double step mode. Non-signal reception can be caused by low battery voltage. If this occurs, replace the batteries.

PART 3 - EXECUTION

3.01 GENERAL

A. Start-Up Service: At completion of installation and prior to final acceptance, start up the equipment, assure that all equipment is operating properly, and that all clocks are functioning.

B. Adjusting: Prior to final acceptance, inspect each clock, adjust as required, and replace parts which are found defective.

C. Cleaning: Prior to final acceptance, clean exposed surfaces of clocks, using cleaning methods recommended by clock manufacturer. Remove temporary labels from clock faces. Do not remove labels from backs of clocks.

D. Demonstration: Provide training to Owner's representative on setting and adjusting clocks, replacing batteries and routine maintenance.

E. Protection: Protect finished installation until final acceptance of the project.

F. Owner's Manual: Provide the Owner with (3) manuals including equipment cuts, installation instructions, maintenance instructions, "as built" drawings of work installed under this contract.

3.02 INSTALLATION

A. GPS Unit: Install on roof in location indicated, approximately 48” above roof, in clear view of the sky. Install unit in location free from standing water, and above accumulations of snow, leaves or debris. Seal cable connection to GPS with cable connection sealant. Signal cable shall enter building immediately adjacent to receiver. Long runs of exposed cable is not permitted. Provide wall or roof penetration with pitch pocket for cable entrance.

B. Transmitter: Locate transmitter where indicated, a minimum of 4 feet above the floor, away from large metal objects such as filing cabinets, lockers or metal framed walls. Note: top of antenna should be as high to ceiling as possible.

1. Attach receiver to transmitter using coaxial cable.
2. Connect antenna to transmitter, using care not to strip threads.
3. Connect power supply to the transmitter.
4. Set the channel number on the display to correspond to the FCC license.
5. Provide #6 grounding electrode conductor.

C. Clocks: Perform the following operations with each clock:

1. Install D-cell batteries.
2. Set clock to correct time in accordance with manufacturer's instructions.
3. Observe clock until valid signals are received and clock adjusts itself to correct time.
4. Install the clock on the wall in the indicated location, plumb, level and tight against the wall. Attach using clock-lock hanging method and suitable fasteners as approved by clock manufacturer.

D. Wire Guards: Secure to wall, using approved theft-resistant fasteners.

END OF SECTION

SECTION 283111 - FIRE ALARM SYSTEM RENOVATIONS

PART 1 - GENERAL

1.01. RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections apply to work in this section.

1.02. WORK INCLUDED

A. Provide labor, materials, equipment and services to perform operations required for the complete installation and related Work as required in Contract Documents.

1.03. GENERAL REQUIREMENTS

A. Provide modifications and wiring required to connect to the existing Edwards EST3 Fire Alarm Control Panel. Open Systems Metro contact – George Aloia (914) 241-0057.

B. Provide all equipment and accessories for a complete, electrically supervised, fire alarm system.

1.04. QUALITY ASSURANCE

A. Conform to requirements of NFPA 70 and NFPA 101.

B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years' experience.

C. Supplier Qualifications: Authorized distributor of specified manufacturer with minimum three years documented experience.

D. Installer Qualifications: Company specializing in installing the products specified in this section with minimum three years' experience.

E. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.05. REFERENCES

A. Codes

1. The following Articles of the National Electric Code (NFPA 70)
   a) Article 760 - Fire Alarm Systems

2. The following National Fire Protection Agency (NFPA) standards:
   a) NFPA 72 - National Fire Alarm Code
   b) NFPA 90A - Installation of Air Conditioning and Ventilating Systems
   c) NFPA 101 - Life Safety Code

3. The following U.L. Standards:
   a) UL 864/UOJZ,APOU - Control Units for Fire Protective Signaling Systems
   b) UL 268 - Smoke Detectors for Fire Protective Signaling Systems
   c) UL 268A - Smoke Detectors for Duct Applications

d) UL 521 - Heat Detectors for Fire Protective Signaling Systems
e) UL 228 - Door Holders for Fire Protective Signaling Systems
f) UL 464 - Audible Signaling Appliances
g) UL 1638 - Visual Signaling Appliances
h) UL 38 - Manually Activated Signaling Boxes
i) UL 1481 - Power Supplies for Fire Protective Signaling Systems

4. Building Code of New York State

5. Fire Code of New York State

1.06. SYSTEM DESCRIPTION

A. Prior to beginning work, review the existing sequence of operation. The existing sequence of operation shall be maintained.

B. All fire alarm pull stations and a/v units shall be red unless otherwise indicated including junction boxes, exposed back boxes and cover plates.

C. Provide activation of necessary functions at the Fire Control Panel as directed by the particular elements in alarm or activated.

1.07. SUBMITTALS

A. Provide submittals for the entire system including:

1. Provide a complete system test report of the existing system by a technician certified by the system manufacturer. Submittal shall include report for owner's reference.

2. Complete equipment list including quantities.

3. Riser Wiring Diagram showing all devices, wire quantities and sizes.

4. Calculations, including actual equipment loads used to derive battery backup ampere-hour rating.

PART 2 - PRODUCTS

2.01 FIRE ALARM CONTROL PANEL

A. Provide additional expansion cards in existing fire alarm control panel as required. Expansion cards shall be of the same manufacture as the existing panel.

B. Provide all programming as required for installation of new devices and expansion cards.

C. Provide additional NAC power supplies as required for additional notification device loads.

D. System circuits shall be configured to match existing system.

2.02 INITIATION DEVICES

A. Provide initiation devices to match existing initiation device. Field verify existing manufacturer and part numbers of devices prior to ordering.

B. Provide wire guards (WG) or guards (G) where called for on plans. Provide guards on all existing and new manual pull stations as indicated in plans. Field verify existing guard manufacturer and part numbers prior to ordering.

C. Heat Detector layout is based on the following criteria.

1. Provide Combination rate-of-rise (15oF per minute) and 135oF fixed temperature.
2. Provide 190oF fixed temperature for boiler rooms and as noted on plans.
3. 30 ft listed spacing.

D. Smoke Detector layout is based on 30 ft. listed spacing.

E. Furnish Duct Smoke Detectors, installed by MC. Provide remote test switches for all Duct mounted Smoke Detectors. Refer to plans for NEMA 4x Duct Smoke Detector types required. Coordinate final installations with MC.

2.03 NOTIFICATION DEVICES

A. Provide notification devices to match existing initiation devices. Field verify existing manufacturer and part numbers of devices prior to ordering.

B. Visual notification device layout is based on 100 Candela-Second Zenon flash output. Provide additional devices as required to meet NFPA requirements.

C. Audible notification device layout is based on a rated 104 dB at 10 ft. Provide additional devices as required to meet NFPA requirements.

D. Provide wire guards (WG) where called for on plans.

2.04 OUTPUT DEVICES AND RELAYS

A. Provide output relays to match devices. Field verify existing manufacturer and part numbers of devices prior to ordering.

B. Visual notification device layout is based on 100 Candela-Second Zenon flash output. Provide additional devices as required to meet NFPA requirements.

C. Audible notification device layout is based on a rated 104 dB at 10 ft. Provide additional devices as required to meet NFPA requirements.

2.05 FIRE ALARM CABLING

A. All wiring shall be twisted, copper. Wire must be certified for use by manufacturer. Wiring shall be sized as follows

1. Minimum #16 AWG for station circuits
2. Minimum #14 AWG for signal and detector circuits
3. Minimum #12 AWG for power supply circuits.
4. Provide large wire where required for voltage drop.

B. Wire must be plenum riser rated, red in color.

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

A. Refer to Division 1.

B. All installations shall be by qualified personnel regularly engaged in and experienced in this type of Work.

C. Detection and initiating equipment shall be listed by UL or approved by FM.

D. Key all new panels, manual pull stations, etc. to match existing.

3.02 INSTALLATION

A. Install manual station with operating handle 4 feet above floor. Install audible and visual signal devices 6 feet 8 inches above floor.

B. Provide steel wire guards (WG) at all exterior notification devices as well as in gymnasiums, multipurpose rooms and locker rooms.

C. During installation and testing, and prior to the system being put into service, all manual stations shall be appropriately marked "NOT IN SERVICE" by the Contractor.

D. Wiring to all initiation and signal circuits shall be wired to match existing classification.

E. All wiring shall conform to N.E.C. Articles 725 and 760, and to NFPA-72, "National Fire Alarm Code".

F. All surface mounted devices shall be mounted on a special box furnished by fire alarm equipment manufacturer. Total assembly shall be secure, smooth contour and have no protrusions.

G. Where detectors are installed on wood or masonry surfaces, attach brackets directly to the surface with tamperproof fasteners. Where detectors are installed on suspended ceilings, provide additional supports in the ceiling, such as channel support system, angle iron or additional runner bars. Fasten the additional supports rigidly to the ceiling runner bar system. Attach bracket to the supports with tamperproof fasteners. Install metal spacers between the bracket and supports so that the ceiling tiles will not be a part of the support system.

H. Provide all wiring to duct smoke detectors. Duct smoke detectors shall be mounted on the ventilating ductwork by others. All mounting arrangements, holes cut into ductwork, sealing of openings along with ceiling and access doors for the duct type detectors shall be by others. Furnish duct detectors along with sampling tubes with end caps. Refer to Smoke Damper details for additional Duct Smoke Detector requirements.

I. Provide all wiring to post indicator valves and alarm check valves provided by others. Wire into the trouble mode of the fire alarm system.

J. Provide all wiring to the smoke dampers installed by others. Wire to the damper junction box with flexible conduit and wire; provide box or boxes as required. Install according to N.E.C. Article 300-22. Smoke dampers shall operate only when its associated smoke duct detector is in alarm.

K. Sequence smoke damper operation thirty seconds after its associated fan has been shut down. Refer to Smoke Damper details for additional requirements.

L. Provide all wiring required for fan shutdown. Wire normally closed fan relay contacts in the Fire Alarm Control Panel ahead of all automatic devices.

M. Audible/Visible Device Installation:

1. Field verify audible alarm type in existing building and provide to match.

2. Devices shall be installed at eighty inches (80") minimum above the floor, or six inches (6") below the ceiling, whichever is lower, in accordance with ADA guidelines.

3. Audible devices intended for operation in public spaces shall have a sound level of not less than seventy-five (75) dBA at ten feet (10'), nor more than 110 dBA at the minimum hearing distance from the device.

4. Audible devices intended for operation in private spaces shall have a sound level of not less than forty-five (45) dBA at ten feet (10'), nor more than 110 dBA at the minimum hearing distance from the device.

5. All audible emergency alarm signals shall be at least 15 dbA over the existing sound level within a space or shall exceed the maximum sound level by 5 dbA for at least 60 seconds, whichever is louder. Within areas occupied by persons with hearing impairments, audible emergency alarms must have the intensity and frequency to provide notification of an alarm condition.

N. Wiring:

1. Install all wiring in accordance with manufacturer's recommendations.

2. All wiring shall be installed in EMT conduit or surface raceway in a separate and segregated system.

3. Provide surface raceway wiremold for all finished areas.

4. Install all 120 volt wiring in separate conduit.

5. All exposed wiring shall be installed in EMT conduit or surface raceway. Existing conduit if acceptable may be used. Fire rated cabling may be run above accessible ceilings. Cable in mechanical rooms, crawl spaces and exterior shall be run in conduit.

6. All wiring not in conduits shall be plenum rated and fire rated and installed in a separate bridle ring raceway system, located on 4’ centers.

7. Wiring shall be continuous from device to device. Splicing shall be accomplished by use of terminal blocks in locked cabinets keyed alike with the fire alarm control unit, or junction boxes. No connections or splices shall be made underground.

8. Control cabinets shall not be used as pull boxes or raceways. Wiring gutters and locked terminal cabinets shall be used.

9. The Fire Alarm System wiring shall be installed in a workmanlike manner, subject to the approval of the project manager

10. All harnessing of wires shall be accomplished by use of approved nylon tie wraps.

11. All wiring shall be numbered and color coded in accordance with this Specification.

12. Tests of all wiring shall be conducted for proper connection, continuity, and resistance to ground. The minimum allowable resistance between any two conductors or between conductors and ground is one (1) megohm as checked by a "megger" after all conduit, conductors, detector bases, etc. have been installed, but before the detector devices are plugged into the base or end-of-line devices installed.

O. Routing:

1. All fire alarm system conduits shall be provided either parallel or perpendicular to building structural members.

2. All fire alarm system pathways shall be provided at a height so as not to obstruct any portion of a window, doorway, stairway, or a passageway, and shall not interfere with the operation of any existing mechanical or electrical equipment.

3. All fire alarm system pathways and cable shall be routed to minimize the potential for physical damage, either mechanical or by fire.

4. All fire alarm system junction boxes, pull boxes, terminal cabinets, control enclosures and device back boxes shall be readily accessible for testing, service and maintenance.

P. Mounting and Labeling of Devices:

1. All fire alarm devices shall be rigidly mounted, using appropriate back boxes, to building structural members, permanent walls, ceilings or fixtures designed for the purpose.

2. All devices shall be labeled with device address or device count as appropriate. Label shall be sticky back type attached to base of device. Label identification shall be consistent with As-Built drawings.

Q. Color Coding and Wire Numbering:

1. All conductors entering and leaving terminal cabinets and junction boxes shall be numbered in a logical and consecutive manner.

2. All conductors shall be color coded. Color coding shall be by wire insulation, not taping or banding. The numbering and color coding shall be continuous for each circuit wire.

3. Wire shall be coded and number to match existing coding and numbering schemes.

4. Wires shall be numbered at each connection, termination, and junction point. Wire numbering tags shall be Brady Perma-Code, Westline, or equal.

3.03 TESTING

A. After complete installation of the equipment and submittal of as-built drawings, the Contractor shall perform complete tests of the system. After these tests have been completed, the Contractor shall request final acceptance inspection and tests in the presence of the Project Manager and local authority. Coordination of final acceptance test date and times with those to be present is the responsibility of the Contractor. The Contractor shall demonstrate that all conditions of the plans and specifications have been met. The tests shall include proper operation of all devices and testing of supervised circuits. The installation will be checked against the as-built drawings. The Contractor shall furnish all testing materials and instruments. A punch list will be developed and the Contractor shall correct punch list items. There will be a re inspection of punch list items. If additional re inspections are found necessary to assure compliance with the Contract, they shall be made at the Contractor's expense.

B. Final acceptance tests shall be coordinated by the contractor and performed in the presence of the owners representative as follows:

1. Operation of the fire alarm control panel and indicating components in accordance with factory recommended procedures.

2. Operational tests of all devices (i.e., detector, waterflow indicator, manual pull box, and valve supervisory device) in accordance with the factory recommended procedures.

3. Audible/visible testing of all indicating appliances. Tests shall include sound level (dBa) and light intensity (lumens).

4. Checks of each initiating circuit or device address for correct indications at the control unit, and any remote annunciator. i.e. Operation of the S.T.U. including receipt of the appropriate zoned signal at the Palo Alto Communications Center.

5. A checkout report shall be prepared by the contractor and submitted to the Project Manager. The checkout report shall include a listing of detector sensitivity for each detector. The report shall summarize the results of all tests and shall serve as the contractor's certification that the system is properly installed and fully functioning.

3.04 MANUFACTURER'S FIELD SERVICES

A. Include services of technician to supervise installation, adjustments, final connections, and system testing.

B. Prior to the final inspection, "pre-test" the entire fire alarm system to assure that all new equipment is properly installed and functions in accordance with plans and specifications.

C. The Manufacturer's representative shall certify that the entire new and existing installation was tested and performed satisfactorily.

3.05 DEMONSTRATION AND INSTRUCTION

A. Demonstrate normal and abnormal modes of operation, and required responses to each.

B. Provide a minimum of 4 hours of instruction to the operating personnel designated by the Owner's Representative with regard to use and operation of the system. Content of the training shall include:

1. Overview of system operations.
2. Overview of system equipment and device locations.
3. Detailed operation guidelines.
4. Periodic maintenance procedures.
5. Periodic testing procedures

3.06 WARRANTY

A. The complete fire protection system shall be fully tested and guaranteed for a period of one year after Owner's Representative written acceptance.

3.07 COMPLETION AND ACCEPTANCE

A. The complete fire protection system shall be fully tested and guaranteed for a period of one year after Owner's Representative written acceptance

B. Prior to request for final payment submit a quantity of bound Operator Manuals that shall include as a minimum:

1. Shop drawings.

2. Bill of Material.

3. Manufacturer's equipment description for each piece of equipment, each device and each initiation and control module type used.

4. Record Drawings for fire alarm wiring diagrams showing typical connection diagrams for each type of device and a complete riser diagram showing all devices, zones, and wiring requirements. Record Drawings for fire alarm wiring diagram shall show all terminal connections at all panels.

5. Instruction report stating when instruction was given and who was in attendance, signed by the Owner's Representative.

6. Submit a written test report from an authorized representative of the equipment manufacturer that each device and overall system operation has been 100% tested and approved. (Both new and existing systems).

7. One year warranty statement in accordance with the Basic Requirements Section of these specifications.

8. Certificate of Completion as described in NFPA-72, Section 1-7.2.

END OF SECTION