TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER™

Project Manual for

Texas Tech University Health Sciences Center

Preston Smith Research Library Renovation Levels 1 & 2

Lubbock, Texas

Issue for Construction

March 21, 2025

Volume 2

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Client	TTUHSC
Page Project Number	320026.05

SECTION 000107 - PROFESSIONAL SEALS
Texas Tech University Health Sciences Center
Preston Smith Research Library Level 01/02 Renovation
Lubbock, Texas

- **DESIGN PROFESSIONAL OF RECORD**
  - **Architecture:**
    1. Sealer's Firm: Page, Inc
    2. Responsible for:
       a. Division 00 and 01 Sections ONLY AS NOTED
       b. 024119 Selective Demolition
       c. 033543.16 Sealed Concrete Finishing
       d. 055001 Metal Fabrications Interior
       e. 060660 Plastic Fabrications
       f. 061001 Rough Carpentry Interior
       g. 064100 Architectural Wood Casework
       h. 068316 Fiberglass Reinforced Paneling
       i. 078400 Firestopping
       j. 078413 Penetration Firestopping
       k. 079200 Joint Sealants
       l. 081113 Hollow Metal Doors and Frames
       m. 081416 Flush Wood Doors
       n. 083113 Access Doors and Frames
       o. 083346 Overhead Coiling Countertop Grills
       p. 084113.23 Interior Aluminum-Framed Storefronts
       q. 087100 Door Hardware
       r. 088000 Glazing
       s. 090561 Common Work Results for Flooring Preparation
       t. 092216 Non-Structural Metal Framing
       u. 092900 Gypsum Board
       v. 093000 Tiling
       w. 095123 Acoustical Tile Ceilings
       x. 096516 Resilient Sheet Flooring
       y. 096623 Resinous Matrix Terrazzo Flooring
       z. 096813 Tile Carpeting
       aa. 097723 Fabric-Wrapped Acoustical Panels
       bb. 098413 Fixed Sound-Absorptive Panels

2025-03-21

SECTION 000107 - PROFESSIONAL SEALS

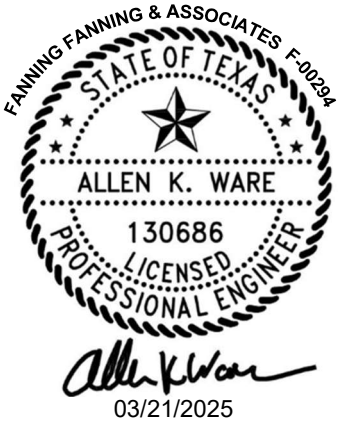
Texas Tech University Health Sciences Center
Preston Smith Research Library Level 01/02 Renovation
Lubbock, Texas

- **DESIGN PROFESSIONAL OF RECORD**
  - **Mechanical Engineering:**
    1. Sealer's Firm: Fanning, Fanning & Associates, Inc.
    2. Responsible for:
       a. 230000 General Provisions for Mechanical/Electrical
       b. 233000 Piping and Accessories
       c. 233800 Marking and Identification
       d. 234000 Air Distribution
       e. 235000 Hangers and Supports
       f. 236000 Insulation
       g. 237000 Equipment
       h. 237100 Rooftop Unit for Rare Books Room
       i. 238000 Contract for Testing, Adjusting and Balancing Mechanical System (Not in Contract - Information Only)
       j. 250000 Temperature Regulation

SECTION 000107 - PROFESSIONAL SEALS

Texas Tech University Health Sciences Center
Preston Smith Research Library Level 01/02 Renovation
Lubbock, Texas

- **DESIGN PROFESSIONAL OF RECORD**
  - **Electrical Engineering:**
    1. Sealer's Firm: Fanning, Fanning & Associates, Inc.
    2. Responsible for:
       a. 260100 Basic Electrical Requirements
       b. 260518 Wires and Cables
       c. 260525 Grounding and Bonding
       d. 260532 Raceways
       e. 260534 Boxes
       f. 260552 Electrical Identification
       g. 260943.13 Digital-Network Lighting Controls
       h. 262416 Panelboards
       i. 262726 Wiring Devices
       j. 262815 Safety Switches
       k. 264600 Dry-Type Transformers
       l. 265100 Lighting
       m. 283300 Fire Alarm and Detection System



03/21/2025

SECTION 000107 - PROFESSIONAL SEALS
Texas Tech University Health Sciences Center
Preston Smith Research Library Level 01/02 Renovation
Lubbock, Texas

- **DESIGN PROFESSIONAL OF RECORD**
  - **Plumbing Engineering:**
    1. Sealer's Firm: Fanning, Fanning & Associates, Inc.
    2. Responsible for:
       a. 210000 Fire Protection Sprinkler System
       b. 223000 Plumbing Systems

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END OF SECTION 000110

210000 - FIRE PROTECTION SPRINKLER SYSTEM

PART 1 - GENERAL

1.1 NOTE

A. Drawings, General Conditions of the Contract for Construction, Supplementary Conditions and Division 1 - General Requirements apply to Work of this Section.

1.2 SUBMITTALS

A. Submit manufacturer's data on all materials, provide complete plan layout of system and hydraulic calculation (for hydraulic design) for approval. Hydrostatic test is required. The Contractor shall confirm at the time of submittal that a complete set of shop drawings has been sent to FM Global for review.

1.3 SCOPE

A. Each renovated building area shall be protected by an FM Global Hazard Category HC-1, automatic sprinkler system. The design and installation shall be done by a Contractor regularly engaged in the construction of fire protection sprinklers systems and licensed for such by the authorities having jurisdiction. Relocate sprinkler heads as required to achieve full coverage per NFPA 13. Submit shop drawings and fully certify the installed system. Submit all documentation to the TTUHSC Fire Marshal for approval. Note that the existing system is a pre-action sprinkler system, actuated by multiple devices. Convert the existing pre-action system to a wet fire protection sprinkler system complying with NFPA 13 for wet fire protection sprinkler system. Remove components serving the second floor preaction system to convert the system to a wet system. Existing sprinkler drawings are available on request from TTUHSC.

1.4 APPLICABLE SPECIFICATIONS

A. The design and installation of the Automatic Sprinkler Systems and the Alarm and Supervisory Systems shall be in strict accordance with all mandatory and recommended provisions of the NFPA, FM, UBC, and UL publications. All recommended provisions of the NFPA (National Fire Codes) listed below shall be considered as mandatory requirements.

B. Issues of the following publications, including revisions and amendment as of the date of award of this contract, form a part of this specification.

1. National Fire Protection Association Standards (NFPA)
2. No. 101 Life Safety Code
3. No. 99 Hospital Code (as required)
4. No. 13 Sprinkler System
5. No. 70 National Electrical Code
6. No. 72C Remote Station Protective Signaling Systems
7. No. 24 Outside Protection
8. Factory Mutual System, Factory Mutual Engineering Corporation Publication (FM)
9. Underwriter's Laboratories, Inc. Publication (UL)
10. Approved Equipment Lists (with supplements).
11. Interpretations of state and local authorities

PART 2 - GENERAL

2.1 GENERAL

A. All material and equipment shall be new and the current standard products of the manufacturer. Where two or more items of equipment performing the same function are required, they shall be exact duplicates, produced by one manufacturer. However, component parts need not be products of the same manufacturer.

B. All materials and equipment shall be UL listed and/or FM approved for systems of the type indicated on the drawings, unless otherwise noted, and shall conform to the requirements of NFPA No. 13.

2.2 MATERIALS AND EQUIPMENT

A. The following is a listing of the materials and specifications. The list is comprehensive in nature. It is not intended that all materials listed will necessarily be required, but that those required for the work be selected from this listing. All pipe and fittings shall be non-galvanized, except where called for on the drawings or required by code.

ITEM	SIZE (INCL)	SPECIFICATIONS
Pipe	All	Schedule 40 steel, ASTM A120 or A53
Fittings, Grooved	All	Schedule 10, ASTM 120 Fir Grooved Fittings
Fittings, Screwed	All	Malleable iron, 150 lb, ANSI B16.3. Cast iron is not acceptable.
Fittings, Press-Connect	Thru 2”	Carbon Steel, IAPMO PS-117, UL/ULC, FM.

Fittings, Flanged	All	Steel, 150 lb, ANSI B16.5. Cast iron is not acceptable.
Fittings, Welding	All	Steel, Sch. 40, ANSI B16.9
Flanges	All	Steel, 150 lb, ANSI B16.5. Cast iron is not acceptable.
Threadolets Sockolets	Thru 2"	Steel, ANSI B16.11 ASTM A105
Weldolets	2" and larger	Steel, 90 degrees STD only, ANSI B16.9, ASTM 105
Plugs	All	Brass, square head, 125 lb, ANSI B16.5
Unions	Thru 2"	Malleable iron, 300 lb bronze to iron ground joint
Flange Gaskets	All	Red rubber 1/16 inch, ANSI B16.21
Valves:		
Globe Valves	Thru 2"	Screwed, bronze body, rising stem, 175 lb WWP, screw-in bonnet, renewable disc, NIBCO KT-65-UL/KT-211-W-UL, Kennedy Fig. 97.
Angle Valves	Thru 2"	Screwed, bronze body, rising stem, 175 lb WWP, screw-in bonnet, renewable disc, NIBCO KT-67-UL/T-301-W, Kennedy Fig. 98.
Gate Valves	Thru 2"	Screwed, bronze body, OS&Y, 175 lb WWP, NIBCO T-104-0, Kennedy Fig. 66.
Gate Valves	2-1/2" & Larger	Flanged, iron body, OS&Y, 175 lb WWP, NIBCO F-607-OTS, Kennedy Fig. 68.
Check Valve	Thru 2"	Screwed, bronze body, 175 lb WWP, horizontal swing, renewable disc, NIBCO KT-403-W, Kennedy Fig. 442.
Check Valves	2-1/2" & Larger	Flanged, iron body, 175 lb WWP, bolted bonnet, horizontal swing, renewable seat & rubber faced disc, NIBCO F-908-W, Kennedy Fig. 126A.

Auto Ball Drip	1/2 or 3/4	Bronze, Grinnell Model F775.
Sprinklers and Nozzles:		
Automatic Sprinklerhead, Standard upright and pendant		Reliable Model G Head type, orifice size, thread size, 165 degree temperature rating satin chrome finish where exposed in finished areas. Provide quick response heads where required.
For drywall Hex Ceiling elements		Fully recessed, fully concealed sprinkler head with white concealer button, flush mounted with ceiling. Quick response head. Provide UL/FM drops to center heads in tiles.
For lay in ceilings in 2nd Floor		Semi-recessed, white powder coated sprinkler head with white powder coated escutcheon
Sidewall		Grunau Institutional model PH-3. Quick response head.
Water Flow Alarm Devices:		
Alarm check valves		Existing to remain.
Water Motor Gong		Existing to remain.
Miscellaneous:		
Pipe Hangers Supports, and Connections		Approved type, in accordance NFPA No. 13 and No. 15 requirements.
Pipe Escutcheons		Chromium-plated iron or chromium- plated brass, either one piece or split pattern, held in place by internal spring tension or setscrew.
Sprinkler Escutcheon		Two-piece, finish to match sprinkler except where otherwise specified on drawings. Depth as required to position sprinkler.
Sprinkler Guard		Approved guard, standard baked red enamel finish.
Hypochlorite		AWWA 300

Water Pressure Gage	Existing to Remain.
Siamese	Existing to Remain.

PART 3 - GENERAL

3.1 JOINTS

A. Joints shall be grooved or threaded type for 2" and smaller, and shall be grooved, welded or flanged for 2-1/2" and larger.

B. Threaded Joints: Threads shall be concentric with the outside of the pipe and shall conform to ANSI B2.1. Threaded joints shall be made tight with an approved thread joint compound or tape. Joint compound shall be applied lightly but sufficiently to cover male threads only. Leaking joint shall not be repaired by peaning or packing.

C. Flanged Joints: Flanged joints shall be faced-true, provided with 1/16-inch red rubber gaskets, and made square and tight. When made up, flange bolts shall extend through nuts by at least one full thread. No flanges shall be placed in locations which will be inaccessible after erection.

D. Press Connect Joints: At the Contractor’s option, NIBCO Bench Press or Viega MegaPress steel fittings may be used: Fittings shall conform to IAPMO PS 117. EPDM elastomeric sealing elements. All connections shall bear full insertion marks on the tubing. Press Connect fitting shall have Leak Detection as standard feature to detect unpressed fittings during the testing process. There shall be no mixing of manufacturers. The manufacturer’s installation instructions shall be strictly adhered to. Special attention shall be given to the required two step pressure test. Initial test for unpressed fitting detection per manufacturer’s installation manual, then full pressure test to 1.5 times design pressure. Installers shall be credentialed by manufacturer. Approved manufacturers: NIBCO, Viega

E. Welded Joints: All welding, including methods and qualifications of welders, shall be in strict accordance with the standards and requirements specified in NFPA Nos. 13 and 15. All welds are subject to inspection by the Contracting Officer. The Contracting Officer reserves the right to accept, reject, or demand removal of welds which are in violation of these specifications. Welded branch connections to headers shall be made by use of threadolets, sockolets or weldolets type fittings.

F. Cutting: Pipe shall be cut accurately to measurements shown on the shop drawings and to suit field conditions and shall be carefully worked into place without forcing or springing. All cuts shall be reamed to remove fins and burrs.

3.2 INSTALLATION

A. Piping material, including valves and fittings, shall be delivered to the site in a clean and protected condition. End seals of pipe, valves and flange covers shall be maintained in place, being removed only as necessary for cleaning, fabrication, erection or for inspection by the Contractor. Care shall be exercised in the handling and storage of all piping materials and prefabricated piping so that contamination by moisture, grease, dirt, or injurious foreign matter shall not occur.

B. The pipe shall be cut accurately to centerline measurements to suit field conditions and shall be carefully worked into place without forcing or springing. Piping shall be pitched to allow proper drainage.

C. The interior and exterior surfaces of all piping shall be kept clean at all times. Pipe shall be free from fins and burrs and shall be cleaned in accordance with cleaning procedures herein.

D. No flanges or unions shall be placed in locations which will be inaccessible after erection.

E. All valves shall be properly packed and made leakproof under the test pressures described.

F. All piping passing through walls shall be provided with pipe sleeves two pipe sizes larger than the systems piping they accommodate or approved steel sleeves providing annular space around the pipe. Annular space shall be made weather and watertight.

G. Where pipes pass through fire walls, fire partitions, or floor/ceiling assemblies, a fire seal of mineral wool, or similar noncombustible material shall be packed between the pipe and sleeve.

H. The end of the pendant sprinkler shall have a maximum of 12” unsupported length from the hanger to the pendant.

I. The maximum length of unsupported arm-over shall be 12”.

J. To keep pipe secure during discharge, provide surge protectors, retainer clips, or adjust swivel rods so that the rod touches the pipe.

K. Escutcheons: Pipe escutcheons shall be provided at all finished surfaces where exposed piping passes through floors, walls or ceiling except in boiler, utility, or equipment rooms.

Sprinkler escutcheons shall be provided for all pendant heads through ceilings. Escutcheons shall be fastened securely to the pipe.

L. Signs: All control drain, and inspector's valves shall be provided with porcelainized metal identification signs. All hydraulically designed systems shall be provided with a permanently attached nameplate data sign as recommended by NFPA No. 13.

M. Sprinkler Guards: All sprinkler heads installed within 7 feet of the floor or otherwise subject to mechanical damage shall be equipped with sprinkler guards.

N. Testing: Testing of the sprinkler systems and alarm systems shall be as prescribed by NFPA Pamphlet No. 13 and 72C. Each test shall be in the presence of an authorized representative of the owner. This representative shall sign the Certificate of Inspection as a witness of a successful test. The Contractor shall deliver these certificates of inspection in duplicate to the Architect.

O. Sterilization: All new lines shall be flushed and sterilized with chlorine before acceptance for service. Calcium hypochlorite powder, containing not less than 70% available chlorine, shall be used for sterilization. The amount of chlorine applied shall be such as to provide a dosage of 100 ppm for at least 24 hours. At the conclusion of the 24-hour contract time, Cl2 residual should be at least 20 ppm. The chlorinating material shall be mixed with treated water in an acceptable container and injected directly into the system, the process being repeated until the system is filled. All valves in the system shall be open and closed 3 times during the procedure to insure that the sterilizing mixture is thoroughly and evenly distributed throughout the system. After a contact period of not less than 24 hours, the system shall be flushed with water.

P. Procedure for Placing Systems in Service: The Contractor shall place the systems in service with the operating mediums after purging operations are completed. The Contractor shall furnish all labor and tools required.

Q. Electrical Work: All electrical work in connection with the installation of the fire protection system shall be performed in accordance with Division 26.

R. Spare Sprinkler Heads: The Contractor shall furnish spare heads in accordance with NFPA Pamphlet No. 13. Heads shall be provided in a suitable cabinet and shall be representative of, and in proportion to, the number of each type and temperature rating of heads installed. In addition to the spare heads, the contractor shall furnish not less

than one special sprinkler wrench per cabinet. The Cabinets shall be mounted at the system's riser.

S. Electrical Rooms: Sprinkler piping shall be routed to avoid all Electrical Rooms, except laterals extending into and serving the electrical room.

END OF SECTION 210000

220000 - PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 NOTE

A. Drawings, General Conditions of the Contract for Construction, Supplementary Conditions and Division 1 - General Requirements apply to Work of this Section.

1.2 SUBMITTALS

A. Submit manufacturer's data on all materials.

1.3 SCOPE

A. This section of the specifications requires the furnishing and installation of all equipment, labor, materials, transportation, tools and appliances and in performing all operations in connection with the installation of the plumbing systems.

PART 2 - PRODUCTS

2.1 MATERIALS: Refer to Section "Piping and Accessories".

A. Interior Sanitary Soil, Waste and Drain Lines: Except as otherwise specified or noted on the drawings, piping inside of, under and within 10'0" of the building or other structures shall be bell and spigot, service weight cast iron soil pipe and fittings, each heavily coated at the factory with asphaltum or coal tar pitch and each having the manufacturer's mark or name and the date of manufacture cast on it. Type "K" copper in sizes up to 2" may be used where space is restricted. C.I. joints may be caulked or push-on. Above grade, no-hub may be used, unless otherwise prohibited. **No-Hub Coupling shall be Husky SD 4000, no exceptions!**

B. Sanitary Fixture Waste Arms: Fixtures served by sanitary soil waste and drain lines shall be connected using cast iron pipe and fittings, red brass pipe, Type L hard copper tubing with cast brass drainage fittings or lead. Use brass soldering nipples or ferrules as required.

C. Sanitary Vent Lines: Vents in the sanitary system shall be service weight cast iron bell and spigot pipe and fittings for all lines 2" and larger and standard weight galvanized steel, Type L or heavier weight copper, red brass, or lead for lines smaller than 2" except that the same class of material shall be used throughout, insofar as practicable. C.I.

joints may be caulked or push-on. Above grade, no-hub may be used, unless otherwise prohibited. **No-Hub Coupling shall be Husky SD 4000, no exceptions!**

D. Domestic Water Lines (Hot, Cold and Recirculating): All water lines underground or under slabs on grade shall be of Type K hard drawn copper tubing. All interior water lines shall be Type K hard drawn copper tubing. Where connections are made between copper tubing and cast iron pipe, use adapters. Copper tubing shall be assembled using solder-joint fittings. No lead solder will be permitted. All flanges shall be 150 psig rated.

E. Drain Lines: Type L copper with solder joint fittings.

F. Downspouts and Interior Storm Drain Lines: Bell and spigot, service weight cast iron soil pipe and fittings, each heavily coated at the factory with asphaltum or coal tar pitch. Type "K" copper in sizes up to 2" may be used where space is restricted. C.I. joints may be caulked or push-on. Above grade, no-hub may be used, unless otherwise prohibited. **No-Hub Coupling shall be Husky SD 4000, no exceptions!**

G. Miscellaneous Lines: Such as pilot lines, bleed lines, control and sampling lines, equalizer lines, drains from air vents and relief vents, etc. shall be fabricated of the materials used in the systems to which they are connected.

H. Interior Cleanouts: Cleanouts shall be provided at the bottom of each stack, at each change in direction, and in each horizontal run at intervals not exceeding 50 feet in all interior soil, waste, and drain lines. Where cleanouts occur in walls of finished areas, they shall be concealed behind chrome plated access covers, such as Wade W-8480-R or provided with other special plugs and covers as required to present a finished appearance. Floor cleanouts in unfinished areas shall be Wade W-6000 with threaded adjustable housing, flanged ferrule with cast iron plug and gasket and secured satin bronze scoriated top. Floor cleanouts in finished tile floors shall be Wade W-6000-TS with square tile top; in carpeted areas Wade W-6000-72 with carpet marker. All cleanouts shall be the same size as the line served up to 4" size and shall be 4" for all larger lines.

I. Air Chambers: Air chambers of Type L copper, not less than 12" long and no smaller than the supply pipe, shall be provided and installed in each water supply to each and every fixture, outlet, item of equipment, etc. The length and/or the diameter of these air chambers shall be greater where required to eliminate water hammer. PDI shock absorbers may be used if sized in accordance with PDI recommendations.

J. Vacuum Breakers: On each water supply line serving a plumbing fixture, item of equipment, or other device which has a water supply below the rim of the fixture, or which has a threaded or tubing spout, provide and install an approved vacuum breaker. These vacuum breakers shall be designed to prevent any possible backflow through them. Where these are installed in chrome plated lines, they shall be chrome plated to match.

K. Automatic Air Vents: This Contractor shall furnish and install Crane No. 976 or 977 air vent valves at all high points for the hot water system, as shown and/or as required. Run a 3/4-inch type L hard copper drain line from the discharge of each air vent valve to a floor drain or as directed.

L. Domestic Hot Water Recirculation Valves: Where more than one recirculation circuit is shown on the drawings, each circuit shall be equipped with a self-contained recirculation temperature control valve. The valve shall be equal in all respects to Cimberio 778 and shall meet the following requirements. The Cim 778 (or equal) adjustable thermostatic balancing valve shall regulate domestic hot water flow in the recirculation circuit based on the actual water temperature entering the valve and the desired water temperature set on the valve.

1. The valve shall maintain dynamic control of the recirculating circuit by allowing a small amount of hot water to pass through even when fully closed.
2. The valve shall be field adjustable without the need for gauges or specialized tools as project conditions require.
3. The valve shall be offered in ½ inch NPT, ¾ inch NPT, or 1-inch NPT sizes. B. Cim 778 will allow for increased flow over the minimum rate via a bypass once 160°F is achieved for an automatic legionella flushing period.
4. The valve shall be a DZR Brass ANSI C27453 or EN 12165 CW511L body and internal components and meet the following requirements:
    a. The valve shall be rated to 360 PSI maximum working pressure.
    b. The valve shall be standard NPT and press connections shall also be available.
    c. The valve shall have a temperature regulation range of 105°F-140°F.
    d. The valve shall have a working temperature range of 15°F-200°F.
    e. The valve shall be NSF/ANSI 61 certified for domestic water system use.

f. Spring-loaded thermal actuator delivers sufficient thrust to keep orifice opening clean and free of deposits.

g. The valve shall have two ports for optional thermometer or test pressure plug ports.

h. The valve shall not use plastic as the shutter in the valve

i. Each valve shall have isolation ball valves on each side from the factory to isolate the control valve for maintenance

5. Installation technicians shall review instructions included with each valve by the manufacturer.

a. The valve shall be installed in the return piping branch of each domestic hot water system beyond the branch's final hot water device.

b. Provide additional components as indicated on project drawings.

6. Install in an accessible location for maintenance or provide an access panel for any inaccessible installation locations.

7. Where recirculation valves are installed, provide and install an all-bronze recirculation pump sized for 1.0 gpm per valve provided, at a head loss equal to 25' THD. Install the recirculation pump with check valve at the domestic cold water inlet to the water heater.

2.2 PLUMBING FIXTURES

A. The plate numbers on the drawings represent fixtures that will be acceptable on the job. Approved equal fixtures of Crane, American Standard, Eljer, and Kohler will be acceptable.

B. All exposed trim shall be chrome plated brass. This includes faucets, fittings, stops, risers, strainers, tailpieces, traps, waste, escutcheons, flush valves, brackets, vacuum breakers, goosenecks, hole covers, bolts, nuts and etc.

C. All threaded supply fittings or outlets with tubing nozzles shall have back flow preventers.

D. All fixtures shall have (1/4) turn ball stop valves.

E. Generally all wall hung fixtures shall be provided with chair carriers so that no weight is supported from the wall.

F. All fixtures shall be cleaned before final acceptance.

G. Verify mounting height of each and every fixture before rough-in.

H. Where fixtures mate with irregular walls, the joint shall be grouted with dental plaster, G. E. Silicone or other grout as directed by the Architect.

I. The Contractor shall verify all rough in heights before installation and shall secure a current ruling on heights of handicapped fixtures before rough in to insure that they meet the requirements of the parties having jurisdiction.

2.3 PLUMBING FIXTURE SCHEDULE: Refer to drawings.

2.4 KITCHEN EQUIPMENT CONNECTIONS

A. The Contractor shall disconnect all existing kitchen equipment plumbing connections and reconnect all equipment in the new location. Furnish and install new unions, gas cocks, valves and fittings and all other materials and labor required to provide a complete functional systems.

B. In addition, rough-in and make final connections to all new equipment furnished by others. Furnish and install all stops, waste, escutcheons, etc., required to provide a complete functional system.

PART 3 - EXECUTION

3.1 ISOLATION VALVES

A. The water supplies to each group of fixtures shall have an isolating valve in each line serving the riser. These isolation valves shall be installed at an accessible location. Where these valves are not accessible thru removable ceilings or otherwise, provide access doors in the ceiling or chase.

3.2 INSTALLATION OF PIPING SYSTEMS

A. Refer to PIPING AND ACCESSORIES for requirements for installing pipes. In addition, the following specifications shall apply.

1. Drain Lines and Sanitary Waste: Grade down toward the sewer connection at a uniform slope of 1/4" per foot to serve individual fixtures or not less than 1/8" per foot to serve multiple stacks or outlets. Slope shall be greater where possible and shall never be less than required to produce a flow velocity of 2 feet per second.
2. Vents: Grade up to the vent thru the roof. Terminate not less than 10" above the roof.
3. Water Lines: Grade to established low points and provide valved drains to completely drain the system.

4. Secure and anchor piping in plumbing chases such that there is no movement of flush valves, stops, etc. at fixture rough-ins.

3.3 EXISTING WASTE AND DRAIN LINE

A. Special care and precaution shall be used where existing waste or drain lines are to be opened. The following procedure shall be adhered to at all times when opening existing waste or drain lines: Before opening, prepare a solution of one part household bleach to nine parts water. At every inlet to the affected piping run, add 2 gallons of the solution to flush out the piping. Any worker who has cuts or open skin breaks shall be prevented from working with the waste or drain piping. Workers shall wear approved face shields, gloves, aprons, boots, etc. for protection. In addition, existing piping shall be thoroughly washed inside and out with bleach solution prior to handling by unprotected persons. The safety director or Owner's representative shall be notified prior to commencing work on any existing waste or drain lines.

3.4 TESTING

A. Test all pipes before they are concealed in furrings or chases, insulated, painted, or otherwise covered up or rendered inaccessible. Accomplish testing by sections of lines or systems, as required by conditions during construction. Clean all piping and equipment before testing.

B. Domestic Water Lines Interior: Test for 6 hours at 150 psig. There shall be no leaks whatsoever.

C. Interior Soil, Waste and Vent Lines: Drainage and venting system piping shall be tested with water before the fixtures are installed. Water test shall be applied to the drainage and venting system either in its entirety or in sections. If the entire system is tested, all openings in the pipes shall be tightly closed except the highest opening and the system shall be filled with water to the point of overflow. If the system is tested in sections, each opening except the highest opening of the section under test shall be tightly plugged, and each section shall be filled with water and tested with at least a 10 foot head of water. The water shall be kept in the system, or in the portion under test, for at least 30 minutes before the inspection starts. The system shall then be tight at all joints. Water shall not drop more than 1" in 8 hours.

D. Downspouts and Storm Drains: Test with water under a head of at least 10 ft. System shall be tight at all joints with no leaks whatsoever.

3.5 DISINFECTING

A. After cleaning, flushing and testing, the Contractor shall furnish all labor, equipment and materials necessary for the disinfection of all domestic pipe lines which shall be disinfected by the application of a chlorinating agent. The chlorinating agent may be a liquid chlorine, liquid chlorine gas water mixture, or a calcium hypochlorite solution, which shall be fed into the lines through a suitable solution feed device.

B. The chlorinating agent shall be applied at or near the point from which the line is being filled and through a corporation stop or other approved connection inserted in the horizontal axis of the newly laid pipe. The water being used to fill the line shall be controlled to flow into the section to be disinfected very slowly.

C. The chlorine dose applied to the water entering the lines shall be at least 40 to 60 parts per million. The treated water shall be retained in the pipe lines for a period of not less than 24 hours. At the end of the 24-hour retention period the chlorine residual shall be at least 20 ppm. All treated water shall be thoroughly flushed from the lines until the replacement water in the lines has a chlorine residual of not more than 0.2 parts per million.

END OF SECTION 220000

230000 - GENERAL PROVISIONS FOR MECHANICAL/ELECTRICAL

PART 1 - GENERAL

1.1 SPECIAL NOTE

A. The Architectural and Structural Plans and Specifications, including the supplements issued thereto, Information to Bidders, and other pertinent documents issued by the Architect, are a part of these specifications and the accompanying mechanical and electrical plans, and shall be complied with in every respect. All the above is included herewith, will be issued separately or is on file at the Architect's office, and shall be examined by all bidders. Failure to comply shall not relieve the Contractor of responsibility or be used as a basis for additional compensation due to omission of drawings. Where the Supplementary General Conditions conflict with the General Conditions, the Supplementary General Conditions shall govern.

1.2 CHECKING DOCUMENTS

A. The drawings and the specifications are numbered consecutively. The Contractor shall check the drawings and specifications thoroughly and shall notify the Architect of any discrepancies or omissions of sheets or pages. Upon notification, the Architect will promptly provide the Contractor with any missing portions of the drawings or specifications. No discrepancies or omissions of sheets or pages of the contract documents will relieve the Contractor of his duty to provide all work required by the complete contract documents.

1.3 GENERAL

A. In general, the lines and ducts to be installed by the various trades under these specifications shall be run as indicated, as specified herein, as required by particular conditions at the site, and as required to conform to the generally accepted standards as to complete the work in a neat and satisfactorily workable manner. The following is a general outline concerning the running of various lines and ducts and is to be excepted where the drawings or conditions at the building necessitate deviating from these standards.

B. All piping, conduit and ductwork for the mechanical and electrical trades shall be concealed in chases in finished areas, except as indicated on the drawings. Horizontal

lines run in areas that have ceilings shall be run concealed in those ceilings, unless otherwise specifically indicated or directed.

C. Piping, ductwork, conduits and raceways may be run exposed in machinery and equipment spaces, where serving as connections to motors and equipment items in finished rooms where exposed connections are required, and elsewhere as indicated on the drawings or required.

D. All conduits in any space where they are exposed shall run parallel with the building walls. They shall enter the concealed areas perpendicular with the walls, ceilings or floors. Fittings shall be used where necessary to comply with this requirement.

E. The Contractor shall thoroughly acquaint himself with the details of the construction and finishes before submitting his bid as no allowances will be made because of the Contractor's unfamiliarity with these details. Place all inserts in masonry walls while they are under construction. All concealed lines shall be installed as required by the pace of the general construction to precede that general construction.

F. The mechanical and electrical plans do not give exact details as to elevations of lines and ducts, exact locations, etc., and do not show all the offsets, control lines, pilot lines and other installation details. The Contractor shall carefully lay out his work at the site to conform to the architectural and structural conditions, to provide proper grading of lines, to avoid all obstruction, to conform to details of installation supplied by the manufacturers of the equipment to be installed, and thereby to provide an integrated, satisfactorily operating installation.

G. The electrical plans show diagrammatically the locations of the various electrical outlets and apparatus and the method of circuiting and controlling them. Exact locations of these outlets and apparatus shall be determined by reference to the general plans and to all detail drawings, equipment drawings, roughing-in drawings, etc., by measurements at the building, and in cooperation with other sections, and in all cases shall be subject to the approval of the Architect. The Architect reserves the right to make any reasonable change in location of any outlet or apparatus before installation (within 10 feet of location shown on drawings) or after installation if an obvious conflict exists, without additional cost to the Owner.

H. The mechanical plans do not give exact locations of outlets, fixtures, equipment items, etc. The exact location of each item shall be determined by reference to the general

plans and to all detail drawings, equipment drawings, roughing-in drawings, etc., by measurements at the building, and in cooperation with other sections. Minor relocations necessitated by the conditions at the site or as directed by the Architect shall be made without any additional cost accruing to the Owner.

I. The Contractor shall be responsible for the proper fitting of his material and apparatus into the space. Should the particular equipment which any bidder proposes to install require other space conditions than those indicated on the drawings, he shall arrange for such space with the Architect before submitting his bid. Should changes become necessary on account of failure to comply with this clause, the Contractor shall make such necessary changes at his (the Contractor's) own expense.

J. The Contractor shall submit working scale drawings of all his apparatus and equipment which in any way varies from these specifications and plans, which shall be checked by the Architect before the work is started, and interferences with the structural conditions shall be corrected by the Contractor before the work proceeds.

K. Order of precedence shall be observed in laying out the pipe, ductwork, material, and conduit in order to fit the material into the space above the ceiling and in the chases and walls. The following order shall govern:

1. Items affecting the visual appearance of the inside of the building such as lighting fixtures, diffusers, grilles, outlets, panelboards, etc. Coordinate all items to avoid conflicts at the site.
2. Lines requiring grade to function such as sewers.
3. Large ducts and pipes with critical clearances.
4. Conduit, water lines, and other lines whose routing is not critical and whose function would not be impaired by bends and offsets.

L. Piping, ducts, and conduits serving outlets on items of equipment shall be run in the most appropriate manner. Where the equipment has built-in chases, the lines shall be contained therein. Where the equipment is of the open type, the lines shall be run as close as possible to the underside of the top and in a neat and inconspicuous manner.

M. Exceptions and inconsistencies in plans and specifications shall be brought to the Architect's attention before the contract is signed. Otherwise, the Contractor shall be responsible for any and all changes and additions that may be necessary to accommodate his particular apparatus, material, or equipment.

N. The Contractor shall distinctly understand that the work described herein and shown on the accompanying drawings shall result in a finished and working job, and any item required to accomplish this intent shall be included whether specifically mentioned or not.

O. Each bidder shall examine the plans and specifications for the General Construction. If these documents show any item requiring work under Divisions 21, 22, 23, 25, 26, and 28 and that work is not indicated on the respective "M", "P" & "E" drawings, he shall notify the Architect in sufficient time to clarify before bidding. If no notification is received, the Contractor is assumed to require no clarification, and shall install the work as indicated on the General Plans in accordance with the specifications.

1.4 DIMENSIONS

A. Before ordering any material or doing any work, the Contractor shall verify all dimensions, including elevations, and shall be responsible for the correctness of the same. No extra charge or compensation will be allowed on account of differences between actual dimensions and measurements indicated on the drawings. Any difference which may be found shall be submitted to the Architect for consideration before proceeding with the work.

1.5 INSPECTION OF SITE

A. The accompanying plans do not indicate completely the existing mechanical and electrical installations. The bidders for the work under these sections of the specifications shall inspect the existing installations and thoroughly acquaint themselves with conditions to be met and the work to be accomplished in removing and modifying the existing work, and in installing the new work in the present building and underground serving to and from that structure. Failure to comply with this shall not constitute grounds for any additional payments in connection with removing or modifying any part of the existing installations and/or installing any new work.

1.6 ELECTRICAL WIRING

A. All electric wiring of every character, for power supply, for communications, etc. will be done under Divisions 26 and 28 of these specifications. The Contractor for each section shall erect all his motors in place ready for connections. The Contractor, under Divisions 26 and 28, shall mount all the starters and controls, furnishing the supporting structures and any required outlet boxes. The Temperature Control Contractor shall include in his bid and shall furnish all wiring required for control, including line (120v/1phase/60hz)

voltage wiring and low voltage control wiring. All wiring shall be in conduit. Include extending line voltage electrical to a space in the nearest electrical panel (or as shown on the drawings) and providing breakers as required to terminate all power required to make temperature controls functional.

B. Every electrical current consuming device furnished as a part of this project or furnished by the Owner and installed in this project, shall be completely wired up under Divisions 26 and 28, and is a part of this contract. Verification of exact location, method of connection, number and size of wires required, voltage requirements, and phase requirements is the responsibility of the Contractor under Divisions 26 and 28. If conflicts occur between the drawings and the actual requirements, actual requirements shall govern. The contractor shall coordinate the voltage of all motors and any associated variable frequency drives with the Divisions 26 and 28 contractors prior to ordering the devices.

C. Where no temperature control scope is shown in the documents, it shall be the responsibility of the Divisions 26 and 28 contractors to provide wiring, conduit and switches for the manual control of equipment, unless specifically noted to the contrary on the drawings and specifications.

1.7 MOTORS AND CONTROLS

A. All motors furnished under any of the several sections of these specifications shall be of recognized manufacture, of adequate capacity for the loads involved and wound for the current characteristics shown on the electrical drawings. All motors shall conform to the standards of manufacture and performance of the National Electrical Manufacturers' Association as shown in their latest publications. They shall further be listed by Underwriters Laboratories.

B. Unless otherwise noted, the Contractor under Divisions 21, 22, 23, and 25 shall furnish each motor with a starter and all controls of the types specified or required. These starters shall be of the totally enclosed type, of capacity rating within the required limits of the motors which they are to serve, shall be suitable for the motor current characteristics and shall provide solid state overload protection, providing protection against single-phase events. All starters shall be standard of manufacture and performance of the National Electrical Manufacturers' Association. They further shall be listed by Underwriters Laboratories. Provide overload protection in each phase wire.

1.8 PROGRESS OF WORK

A. The Contractor shall keep himself fully informed as to the progress of the work and do his work at the proper time without waiting for notification from the Architect or Owner.

1.9 MANUFACTURER'S DIRECTIONS

A. All manufactured articles shall be applied, installed and handled as recommended by the manufacturer. All items of equipment provided shall be piped in strict accordance with its manufacturer's written installation instructions. Note that details on the drawings may be for equipment that is ultimately not furnished for the project and is for bidding purposes. Exact configuration shall match manufacturer's installation instructions.

1.10 MATERIALS AND WORKMANSHIP

A. All materials shall be new unless otherwise specified and of the quality specified. Materials shall be free from defects. All materials of a type for which the Underwriters Laboratories, Inc. have established a standard shall be listed by the Underwriters Laboratories, Inc. and shall bear their label.

B. Wherever the make of material or apparatus required is not definitely specified, the Contractor shall submit a sample to the Architect before proceeding.

C. The Architect reserves the right to call for samples of any item of material offered in substitution, together with a sample of the specified material, when, in the Architect's opinion, the quality of the material and/or the appearance is involved and it is deemed that an evaluation of the two materials may be better made by visual inspection. This shall be limited to lighting fixtures, wiring devices, plumbing brass, grilles, registers, ceiling outlets and similar items and shall not be applicable to major manufacturers' items of equipment.

D. The Contractor shall be responsible for transportation of his materials to and on the job and shall be responsible for the storage and protection of these materials and work until the final acceptance of the job.

E. The Contractor shall furnish all necessary scaffolding, tackle, tools and appurtenances of all kinds, and all labor required for the safe and expeditious execution of his contract.

F. The workmanship shall in all respects be of the highest grade and all construction shall be done according to the best practice of the trade.

1.11 SUBSTITUTION OF MATERIALS

A. Unless specifically excepted, where a definite material or only one manufacturer's name is mentioned in these specifications, it has been done in order to establish a standard. The product of the particular manufacturer mentioned is of satisfactory construction and any substitution must be of quality as good as or better than the named article. No substitution shall be made without review by the Architect, who will be the sole judge of equality.

B. Within 30 days of being awarded the Contract for any section or sections of the work under this heading, the Contractor shall submit for approval a complete list of the materials he proposes to use. This list shall give manufacturers' names and designations corresponding to each and every item and the submission shall be accompanied by complete descriptive literature and/or any supplementary data, drawings, etc., necessary to give full and complete details. If the material is not submitted within 30 days of the contract signing, the Contractor shall furnish the specified materials.

C. Should a substitution be accepted under the provisions of the conditions of these specifications, and should this substitute prove to be defective or otherwise unsatisfactory for the service for which it is intended within the guarantee period, the Contractor who originally requested the substitution shall replace the substitute material with the specified material.

D. **No Substitutions shall be accepted for the following:**

1. Johnson Controls
2. Titus VAV Boxes
3. All scheduled plumbing fixtures and trim

1.12 SHOP DRAWINGS

A. Wherever shop drawings are called for in these specifications, they shall be furnished by the Contractor for the work involved after review by the Architect as to the make and type of material and in sufficient time so that no delay or changes will be caused. This is done in order to facilitate progress on the job and failure on the part of the Contractor to comply shall render him liable to stand the expense of any and all delays, changes in construction, etc., occasioned by his failure to provide the necessary details. Also, if the Contractor fails to comply with this provision, the Architect reserves the right to go directly to the manufacturer he selects and secure any details he might deem necessary and

should there be any charges in connection with this, they shall be borne by the Contractor.

B. Shop drawings will be reviewed by the Architect for general compliance with the design concept of the project and general compliance with the information given in the contract documents. Review by the Architect and any action by the Architect in marking shop drawings is subject to the requirements of the entire contract documents. Contractor will be held responsible for quantities, dimensions which shall be confirmed and correlated at the job site, fabrication processes and techniques of construction, coordination of all trades and the satisfactory performance of his work.

C. Shop drawings submitted shall not consist of manufacturers' catalogues or tear sheets therefrom that contain no indication of the exact item offered. Rather, the submission of individual items shall designate the exact item offered and shall clearly identify the item with the project.

D. All shop drawings shall be submitted at one time where possible. If hard copy is submitted, it shall consist of a bound catalogue of all shop drawings under each section. Electronic submittals are preferred. Submit ONE .pdf file per specification section, named as follows: Jobname_23XXXX_SpecSectionName.pdf. Include a cover letter from the contractor as the first sheet of the submittal, certifying that the submittal has been properly indexed and has been checked by the Contractor. Each item submitted shall include a cover letter by the material supplier, clearly indicating exact model numbers and details to be furnished for each item specified in the section.

E. The omissions of any material from the shop drawings which has been shown on the contract drawings or specified, even though reviewed by the Architect, shall not relieve the Contractor from furnishing and erecting same.

1.13 ATTIC STOCK REQUIREMENTS

A. The following specified equipment shall be furnished as attic stock in the quantities specified under the contract:

1. Sprinkler heads, concealer type – qty. 5
2. Sprinkler heads, semi-recessed type – qty. 10
3. RO Filter cartridge sets If RO is provided (all filters included) – 12 sets
4. Custom light fixtures – 100% spare fixtures. See electrical drawings.

B. Deliver this attic stock to the TTUHSC Facilities team during construction.

1.14 PROTECTION OF APPARATUS

A. The Contractor shall at all times take such precautions as may be necessary to properly protect his new apparatus from damage. This shall include the erection of all required temporary shelters to adequately protect any apparatus stored in the open on the site, the cribbing of any apparatus above the floor of the construction, and the covering of apparatus in the incompleted building with tarpaulins or other protective covering. Failure on the part of the Contractor to comply with the above to the entire satisfaction of the Architect will be sufficient cause for the rejection of the pieces of apparatus in question.

1.15 PERMITS, FEES, ETC

A. The Contractor under each section of these specifications shall arrange for a building permit from the city of Lubbock for record purposes. In as much as all utilities at the site are owned by the University, there are no connection fees. If any charges are made by any of the utility companies serving the campus due to work on this project, the Contractor shall pay these charges. The Contractor shall pay for any inspection fees or other fees and charges required by ordinance, law, codes or these specifications.

1.16 TESTING

A. The Contractor under each division shall at his own expense perform the various tests as specified and required by the Architect and as required by the State and local authorities. The Contractor shall furnish all fuel and materials necessary for making tests.

1.17 LAWS, CODES AND ORDINANCES

A. All work shall be executed in strict accordance with all local, state and national codes, ordinances and regulations governing the particular class of work involved, as interpreted by the inspecting authority. The Contractor shall be responsible for the final execution of the work under this heading to suit those requirements. Where these specifications and the accompanying drawings conflict with these requirements, the Contractor shall report the matter to the Architect, shall prepare any supplemental drawings required illustrating how the work may be installed so as to comply and, on approval, make the changes at no cost to the Owner. On completion of the various portions of the work the installation shall be tested by the constituted authorities, approved and, on completion of the work, the Contractor shall obtain and deliver to the Owner a final certificate of acceptance.

1.18 TERMINOLOGY

A. Whenever the words "furnish", "provide", "furnish and install," "provide and install", and/or similar phrases occur, it is the intent that the materials and equipment described be furnished, installed and connected under this Division of the Specifications, complete for operation unless specifically noted to the contrary.

B. Where a material is described in detail, listed by catalogue number or otherwise called for, it shall be the Contractor's responsibility to furnish and install the material.

C. The use of the word "shall" convey a mandatory condition to the contract.

D. "This section" always refers to the section in which the statement occurs.

E. "The project" includes all work in progress during the construction period.

F. In describing the various items of equipment, in general, each item will be described singularly, even though there may be a multiplicity of identical or similar items.

1.19 COOPERATION AND CLEANING UP

A. The contractor for the work under each section of these specifications shall coordinate his work with the work described in all other sections of the specifications to the end that, as a whole, the job shall be a finished one of its kind, and shall carry on his work in such a manner that none of the work under any section of these specifications shall be handicapped, hindered or delayed at any time.

B. At all times during the progress of the work, the Contractor shall keep the premises clean and free of unnecessary materials and debris. The Contractor shall, on direction at any time from the Architect, clear any designated areas or area of materials and debris. On completion of any portion of the work, the Contractor shall remove from the premises all tools and machinery and all debris occasioned by the work, leaving the premises free of all obstructions and hindrances.

1.20 COORDINATION OF TRADES

A. The Contractor shall be responsible for resolving all coordination required between trades. For example, items furnished under Divisions 21, 22, 23, and 25 which require electrical connections shall be coordinated with Divisions 26 and 28 for:

1. Voltage
2. Phase
3. Ampacity
4. No. and size of wires

5. Wiring diagrams
6. Starter size, details and location
7. Control devices and details

B. Items furnished under various sections which require plumbing connections shall be coordinated for services, pressure, size and location of connections, type of fuel, clearances for service, auxiliary devices required, etc.

C. Items requiring insulation shall be fully insulated and that insulation shall be checked against manufacturer's directions and job requirements for suitability, coverage, thickness and finish.

D. Items installed in/on finished ceilings shall be coordinated with the ceiling construction. The Contractor under each section shall conform to the reflected ceiling plan and shall secure details and/or samples of the ceiling materials as necessary to insure compatibility. Any device not conforming to this requirement shall be replaced by the Contractor at his expense.

E. All items specified under Divisions 21, 22, 23, 25, 26, and 28 shall be installed tight, plumb, level, square and symmetrically placed in relation to the work of other trades.

1.21 CUTTING AND PATCHING

A. The Contractor for work specified under each section shall perform all structural and general construction modifications and cut all openings through either roof, walls, floors or ceilings required to install all work specified under that section or to repair any defects that appear up to the expiration of the guarantee. All of this cutting shall be done under the supervision of the Architect and the Contractor shall exercise due diligence to avoid cutting openings larger than required or in wrong locations. Verify the scope of this work at the site and in cooperation with all other trades before bidding.

B. No cutting shall be done to any of the structural members that would tend to lessen their strength, unless specific permission is granted by the Architect to do such cutting.

C. The Contractor for work under each section shall be responsible for the patching of all openings cut to install the work covered by that section and to repair the damage resulting from the failure of any part of the work installed hereunder.

D. Before bidding, the Contractor shall review and coordinate the cutting and patching required under the respective section with all trades.

E. In all spaces where new work under Divisions 21, 22, 23, 25, 26, and 28 is installed and no other alteration or refinishing work is shown or called for, existing floors, walls and ceilings shall be restored to match existing conditions. All cutting and patching shall be done by workmen skilled in the affected trade.

F. Where openings are cut through masonry walls, the Contractor under each respective section shall provide and install lintels or other structural supports to protect the remaining masonry and adequate support shall be provided during the cutting operation to prevent any damage to the masonry occasioned by the operation. All structural members, supports, etc. shall be of the size, shape, and installed as directed by the Architect.

1.22 PAINTING

A. Painting for Divisions 21, 22, 23, 25, 26, and 28 shall be as follows:

1. If the factory finish on any apparatus or equipment is marred, it shall be touched up and then given one coat of half-flat-half-enamel, followed by a coat of machinery enamel of a color to match the original. Paint factory primed surfaces.
2. Paint all exposed pipe, conduit, boxes, cabinets, hangers and supports, and miscellaneous metal.
3. Paint all exposed sheet metal.
4. Paint all insulated surfaces exposed to view, including piping, equipment, etc. Surfaces until a smooth, non-grainy surface is obtained.

B. Generally, painting is required on all surfaces such that no exposed bare metal or insulation surface is visible.

1.23 SEALING

A. The Contractor installing pipes, conduits, ducts, etc., shall seal all spaces between pipes and/or sleeves where they pierce walls, partitions or floors by packing fire resistant rope and fire-resistant cement. The packing shall effect a complete fire and/or air seal where pipes, conduits, ducts, etc., pierce walls, floors or partitions.

1.24 ACCESS PANELS

A. Wherever mechanical and/or electrical equipment is installed and where future access is required through either walls or ceilings and such cannot be obtained through the removable ceiling or through other means, the Contractor shall provide Milcor Style "M" access doors at least 12 inches by 12 inches in size or larger if required for access. Provide access doors for all fire dampers, smoke dampers, valves, etc.

1.25 USE OF SYSTEMS

A. It is considered that it will be necessary to operate the mechanical systems to provide heating and ventilation in portions of the building that are enclosed. As systems or portions of systems become operable, they shall be operated as required to maintain habitable conditions in enclosed portions of the building that are still under construction and portions that are fully complete as may be required to properly protect installed piping, equipment and finishes.

B. In order to provide protection to ducts, plenums, etc. install temporary filters over or in return air openings until all finished painting is completed. Protect supply outlets, coils, etc. as necessary in each case.

C. Except for operation of cooling equipment to prove its performance and to adjust and balance the systems, that equipment will not be operated for comfort of construction workers.

D. During warm weather the Contractor shall arrange for the operation of systems to supply 100 percent outside air. The systems controls shall be reset to their normal cycle of operation in each case during the times that heating is required and when the cooling equipment is operated.

E. Immediately prior to the time that the systems are to be accepted by the Owner, each system shall be carefully examined and if ductwork is dirty, it shall be carefully cleaned by men skilled in that type of work. All filters shall be put in first class condition by replacement of filters and/or other procedures as directed.

F. The use of the equipment for maintaining environmental and/or protective temperature conditions shall in no way constitute acceptance of that equipment and the connected piping, ducts, insulation, finishes, etc. by the Owner. Furthermore, it shall in no way shorten the guarantee period hereinafter specified. The Contractor shall either secure extended warranties from the vendors of equipment or shall purchase insurance to provide proper coverage on the equipment through the guarantee period and shall file with the Architect substantiating affidavits from equipment manufacturers or a copy of the insurance policy covering the equipment through the guarantee period. The personal underwriting of the Contractor for equipment manufacturers' warranties is not acceptable, but his personal underwriting of piping, ductwork, insulation and associated materials is acceptable subject to the provisions of the contract.

G. The Contractor shall provide such labor as may be required in the operation of the systems and shall pay all costs.

1.26 OWNERS OCCUPANCY

A. It shall be understood that the building in which the work is to be done is a necessary part of the Owner's operation and shall continue in use throughout the construction period without interruption. Take all precautions required by the Owner for the protection of his equipment and property.

B. Contractor shall cooperate with the owner in scheduling areas in which work is permitted. Owners schedule will govern.

1.27 SCHEDULE OF WORK

A. The Contractor shall program his work in such manner as to interfere as little as possible with the normal routine of the Owner. It must be understood that the Owner will continue to function throughout the construction period. All water, electrical and sanitary facilities shall therefore be continued in operation with a minimum of interruption and the Contractor shall make any temporary connections necessary to comply with this requirement.

1.28 WORKING TIME

A. Where new connections are to be made into existing lines, present lines must be relocated or rerouted, present equipment items relocated or other work accomplished that would affect the operation of the present building, the work shall be carried on at such times as to cause a minimum of interference with the normal operation of that building. In certain cases, the work may be accomplished during normal working hours during certain designated seasons or times of the year. In other cases, the work may have to be executed during times of the day outside of the normal working period, on holidays, etc. Each individual case presents a separate decision as to the time during which it shall be performed. The Contractor involved shall present each case to the Architect for his decision, which will be made after due consultation with the Owner. No additional compensation for overtime will be granted for compliance with these requirements.

1.29 RELOCATION OF EXISTING INSTALLATION

A. There are portions of the existing plumbing system, heating, ventilating and air conditioning system and electrical System which shall remain in use to serve the finished

building in conjunction with the indicated new installations. By actual examination at the site, each bidder shall determine those portions of the remaining present installations which must be relocated to avoid interferences with the installations of new work of his particular trade and that of all other trades. All such existing installations which interfere with new installations shall be relocated by the Contractor under the Division in which the existing material normally belongs, and in a manner as directed by the Architect. For example:

1. Existing Plumbing piping, etc. shall be relocated under Divisions 21, 22, 23, and 25 where it interferes with the installation of new work.
2. Where existing piping, ductwork, etc. interferes with the installation of new work, it shall be relocated under Divisions 21, 22, 23, and 25.
3. Where existing conduit and electrical equipment interferes with the installation of new work, it shall be relocated under Divisions 26 and 28.

B. Failure to become familiar with the extent of the relocation work involved shall not relieve the Contractor of responsibility and shall not be used as a basis for additional compensation.

1.30 EXISTING WASTE AND DRAIN LINE

A. Special care and precaution shall be used where existing waste or drain lines are to be opened. The following procedure shall be adhered to at all times when opening existing waste or drain lines: Before opening, prepare a solution of one part household bleach to nine parts water. At every inlet to the affected piping run, add 2 gallons of the solution to flush out the piping. Any worker who has cuts or open skin breaks shall be prevented from working with the waste or drain piping. Workers shall wear approved face shields, gloves, aprons, boots, etc. for protection. In addition, existing piping shall be thoroughly washed inside and out with bleach solution prior to handling by unprotected persons. The safety director or Owner's representative shall be notified prior to commencing work on any existing waste or drain lines.

1.31 SALVAGE MATERIALS

A. The Contractor shall remove existing equipment, piping, duct, grilles, conduit, wire, junction boxes, light fixtures and other items associated with the mechanical, plumbing and electrical systems where shown on the drawings. Where such items are exposed to view or uncovered by any cutting or removal of general construction and has no

continuing function (as determined by the Architect), they shall be removed by the contractor under the section in which the item normally falls.

B. Existing items (see above) where concealed in/above construction, which is not disturbed, abandon in place. Plug, cap, disconnect or otherwise render harmless all such items.

C. All items or materials removed from the project shall be made available for the Owner's inspection. The Owner retains the option to claim any item or material. Contractor shall deliver any claimed item or material in good condition to the place designated by the Owner. All item not claimed become the property of the contractor and shall be removed from the site.

1.32 SLEEVE DRAWINGS

A. The Contractor shall, before concrete is poured, prepare 1/8" scale floor plan drawings on tracing paper and shall show on these drawings, with dimension lines, the size and location of every pipe sleeve required for the passage of his lines. Prints shall be reviewed by the Architect prior to the setting of the pipe sleeves.

1.33 INSTALLATION DRAWINGS

A. It shall be incumbent upon the Contractor to prepare special drawings as called for elsewhere herein or as directed by the Architect to coordinate the work under each section, to illustrate changes in his work, to facilitate its concealment in finished spaces to avoid obstructions or to illustrate the adaptability of any item of equipment which he proposes to use.

B. These drawings shall be used in the field for the actual installation of the work. Unless otherwise directed, they shall not be submitted for approval, but three copies shall be provided to the Architect for his information.

1.34 ROUGH-IN AND MAKE FINAL CONNECTION FOR EQUIPMENT

A. The shop drawings for all equipment are hereby made a part of these specifications. The Contractor under each section of the specifications shall rough-in for the exact item to be furnished on the job, whether in another section of the specifications or by the Owner. The Contractor shall refer to all drawings and other sections of the specifications for the scope of work involved for the new equipment, and by actual site examination determine the scope of the required equipment connections for the Owner furnished equipment.

B. Should any of the equipment furnished require connections of a nature different from that shown on the drawings, report the matter to the Architect and finally connect as directed by the Architect.

C. Should any shop drawings not be available for equipment furnished under other contracts or by the Owner, the Contractor under each section of these specifications shall bid the work as detailed on the drawings.

D. Minor differences in the equipment furnished and that indicated on the drawings will not constitute ground for additional payment to the Contractor.

1.35 MARKING OF PIPE

A. The Contractor shall mark all accessible piping systems. The identification of a piping system shall be made by a positive identification of the material content of the system by lettered legend, giving the name of the content in full or abbreviated form. This mark shall be conspicuously placed at frequent intervals on straight runs, close to all valves, at changes of direction and where pipes pass through walls, floors or ceilings. Arrows shall be used to indicate direction of flow. Markers shall be painted on using stencils.

B. Markers shall be placed on piping at each connection to an item of equipment, at each pump, and on each drop to an outlet. Markers shall be placed on each run of piping at intervals not exceeding 50 feet where exposed in a room and 25 feet when installed above removable ceilings, except that no exposed line shall enter a room without being identified therein. Marker on lines above removable ceilings shall be applied on the undersides of the lines and in other areas shall be applied to be most visible. Also supply directional flow indicators adjacent to identification markers.

C. Size of Identification:

Outside Diameter	Size of Legend of Pipe or Covering Letters (" Height)
3/4 to 1-1/4	1/2
1-1/2 to 2	3/4
2-1/2 to 6	1-1/4

1.36 IDENTIFICATION AND LABELING

A. The Contractor shall make it possible for the personnel operating and maintaining the equipment and systems in this project to readily identify the various pieces of equipment, valves, piping, etc., by marking them. All items of equipment such as fans, pumps, etc.,

shall be clearly marked using engraved nameplates as hereinafter specified. The item of equipment shall indicate the same number as shown on the drawings. For example, pumps will be identified as P-1, P-2, P-3, etc.; exhaust fans will be EF-1, EF-2, etc.; AC Units will be AC-1, AC-2, etc.

B. All items of mechanical and electrical equipment shall be identified by the attachment of engraved nameplates constructed from laminated phenolic plastic, at least 1/16" thick, 3-ply, with black surfaces and white core. Engraving shall be condensed gothic, at least 1/2" high, appropriately spaced. Nomenclature on the label shall include the name of the item, its mark number, area, space, or equipment served, and other pertinent information. Equipment to be labeled shall include but not be limited to the following:

1. Boilers
2. Chillers
3. Pumps
4. AC Units
5. Convertors
6. Air Conditioning Control Panels and Switches
7. Exhaust and Return Air Fans
8. Miscellaneous - similar and/or related items

1.37 OPERATING INSTRUCTIONS

A. The Contractor for each section of the work hereunder shall, in cooperation with the representatives of the manufacturers of the various equipment items, carefully instruct the Owner's representatives in the proper operation of each item of equipment and of each system. During the balancing and adjusting of systems, the Owner's representative shall be made familiar with all procedures.

1.38 OPERATING MANUALS

A. Prepare and submit 3 copies of the operating manuals bound in hard covers. Three weeks prior to completion of the work, the Architect will check the manuals and any additional material necessary to complete the manuals shall be furnished and inserted by the Contractor.

B. Manuals shall contain the following data:

1. Catalogue data of all equipment.
2. Shop drawings of all equipment.

3. Temperature control drawings (reduced in size)
4. Start-up instructions for major equipment.
5. Trouble shooting procedures for major equipment.
6. Wiring diagrams.
7. Recommended maintenance schedule for equipment.
8. Parts list for all items.
9. Name and address of each vendor.

1.39 GUARANTEE

A. Unless a longer period is specified elsewhere, the contractor shall guarantee all workmanship and materials for a period of one year from date of final acceptance.

1.40 COMPLETION REQUIREMENTS

A. Before acceptance and final payment, the Contractor under each Division of the specifications shall furnish:
   1. Accurate "as built" drawings, shown in red ink on blue line prints furnished for that purpose all changes from the original plans made during installation of the work. Drawings shall be filed with the Architect when the work is completed.
   2. All manufacturers' guarantees.
   3. All operating manuals.
   4. Guarantees.
   5. Test and Balance Report.

1.41 CONTRACTOR'S RESPONSIBILITY FOR FINAL INSPECTION

A. Before calling for the final inspection, the Contractor under each Division shall carefully inspect his work to be sure it is complete and according to plans and specifications.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION 230000

SECTION 233000 - PIPING AND ACCESSORIES

PART 1 - GENERAL

1.1 NOTE

A. Drawings, General Conditions of the Contract for Construction, Supplementary Conditions and Division 1 - General Requirements apply to Work of this Section.

1.2 SUBMITTALS

A. Submit manufacturer's data on all materials.

1.3 SCOPE

A. This section of the specifications pertains to all labor, materials, equipment and service necessary for and incidental to the piping and accessories as shown on the drawings and/or specified herein.

1.4 INSPECTION

A. All pipe, valves, fittings, and other accessories shall be inspected upon delivery and during the course of the work. Any defective materials found during field inspection or during hydrostatic and leakage tests shall be removed from the site of the work and replaced by the Contractor.

1.5 PROTECTION DURING STORAGE

A. The interior of all pipe, fittings, and other accessories shall be kept free from dirt and foreign matter at all times. Valves and fittings shall be drained and stored in a manner that will protect them from damage by freezing.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All materials shall be manufactured or fabricated in the United States of America.

B. Materials shall conform to the listed standards. Refer to specific sections for materials to be used under that section. The following tabulation is for reference only to identify the applicable standard.

Copper Tubing	ASTM B88
Wrought Copper Solder Fittings	ANSI BI6.22
Cast Bronze Solder Fittings	ANSI B16.18
Steel Pipe	ASTM A120, A53, A106

Butt Weld Fittings	ANSI B16.9
Socket Weld Fittings	ANSI B16.11
Steel Flanges	ANSI B16.5
Malleable Iron Threaded Fittings	ANSI B16.3
Cast Iron Threaded Fittings	Fed. Spec. WW-P-501E

C. Unions in Ferrous Lines: 150 pound malleable iron, screwed pattern, ground joint with brass to iron seat; equal to Crane.

D. Insulating Fittings: Equal to Maloney.

E. Unions in Copper or Brass Lines: 125 pound all brass, screwed pattern, ground joint, equal to Chase, Crane or Mueller.

F. Mechanical Couplings: Victaulic Style 77

2.2 VALVES

A. General Service Valves: 3" and smaller, all bronze, screwed; 3-1/2" and larger, flanged, iron body, bronze trimmed, equal to the following Crane Nos:

Type	Fluid Pressure Below 125 PSIG	Fluid Pressure Above 125 PSIG
Gate 2" and smaller	428	424
Gate 2-1/2" and larger	465-1/2	7-1/2 E
Globe 2" and smaller	1	14-1/2 P
Globe 2-1/2" and larger	351	21E
Angle 2" and smaller	2	16-1/2 P
Angle 2-1/2" and larger	353	23E

B. Where valves have discs, select the discs for the intended service using materials as recommended by the valve manufacturer. Provide extended stems for valves in insulated lines, so that the handle clears the insulation and jacket.

C. Acceptable General Service Valve Manufacturers: Stockham, Jenkins, OIC, Walworth, Hammond.

D. Butterfly Valves: Cast or ductile iron body, flanged or with drilled and tapped lugs, bronze discs, stainless steel shafts with bronze bushings, resilient EPDM seats and O-rings, "Bubble Tight" shut-off at 150 psi pressure. On valves 4" and smaller, handle shall be infinite position with memory stops. On valves 6" and larger, provide geared operators. Norris, Keystone, Center Line, Demco or Crane valves are acceptable. Where valves

are installed in insulated lines, provide extended stems so that the handle will clear the insulation and jacket.

E. Plumbing Isolation Valves: Up to 2” DIA: equal or equivalent to: Milwaukee UPBA300/300S lead free, stainless steel ball & stem, full port construction, Viton O-ring, adjustable packing gland, blow out proof stem design, solder or threaded, and PTFE trim. From 2 ½” DIA up to 4” DIA: American Model 4001: lead free, cast stainless steel, flanged end, blow-out proof stainless steel Stem, and Teflon fused ball valve. Above 4” to 6”: lead free, ductile iron, butterfly valve, and open/close indicator needle. Above 6”: lead free, ductile iron, butterfly valve with gearbox, and open/close indicator needle. Where valves are installed in insulated lines, provide extended stems to clear the insulation and jacket.

2.3 GAUGE COCKS AND GAUGES

A. Where gauge connections are installed in insulated lines, install a ConBraCo No. 41-380 T-handle gauge cock on a nipple of sufficient length that the cock handle will be free of the pipe insulation, and position each cock in relation to surrounding piping and equipment so that the gauge may be easily read, and so that a gauge having a 6" diameter dial can be screwed into and out of the cock.

B. Install gauge cocks at pumps as close to pump suction and discharge connections as possible. Where drilled and tapped gauge connections are provided in the pump casing by the manufacturer, use these tappings.

C. Pressure Gauges: Phosphor bronze, seamless Bourdon spring type with phosphor bronze bushed rotary movement and link; 4-1/2" dial, nickel plated ring, free standing cast aluminum case; equipped with micrometer adjustment pointer. Furnish each gauge with scale range suitable for the duty.

D. Water Pressure Gauges: Equal to Weksler No. BA14-I with cast aluminum case, or EA-14 with stainless steel case; Weksler, Weiss, and Trerice acceptable.

E. Steam Pressure Gauges: Equal to Weksler No. BA14-I with cast aluminum case, mounted on coiled pipe (pigtail) siphons; Weksler, Weiss, Trerice acceptable.

2.4 THERMOMETER WELLS

A. Furnish and install brass or stainless steel closed separable thermometer wells for all thermometer and controller bulbs which are designated for liquid measurements. Whenever a thermometer or controller bulb is inserted in a pipe for either remote or local temperature indication or control, locate the thermometer well so that it will be completely

surrounded by flowing fluid. Such thermometer locations as shown on the drawings are diagrammatic only-install thermometer wells for maximum effectiveness and in the case of locally indicating instruments, for easy readability.

B. Test Wells: Test wells for use with etched stem thermometers shall be Bolton No. 615 brass, with a threaded brass plug and keeper chain. Install these test wells so that they can be filled with oil to facilitate temperature measurements.

2.5 MERCURIAL THERMOMETERS

A. Industrial type with Cycolac plastic cases, glass fronts, 9" scale, adjustable straight or angle pattern as required for ready readability. Furnish thermometers with 2-1/2" stem extensions where they are installed in insulated lines. Select scale ranges for maximum readability at the design temperature of the medium being measured. Thermometer equal to Weksler No. AA5H9.

B. Acceptable Manufacturers: Weksler, Trerice, Weiss, Moeller.

2.6 COMBINATION PRESSURE/TEMPERATURE PORT

A. Furnish and install where indicated "Pete's Plug" a 1/4" MPT fitting to receive either a temperature or pressure probe 1/8" OD. Fitting shall be solid brass with valve core of neoprene fitted with cap with gasket. Furnish an extended stem as required to extend through pipe insulation where installed in insulated lines.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING SYSTEMS

A. Install runs of piping essentially as indicated on the drawings and/or as required. The location, direction and size of the various lines are indicated on the drawings.

B. Make up all systems straight and true and properly graded for correct flow of contained materials and to provide drainage. Cut pipes accurately to measurements established at the building and work into place without forcing or springing. Except as required for specified grading, run all piping above ground parallel with the lines of the building.

C. Make all changes in pipe sizes with reducing fittings. Use no long screws or bushings.

D. Install and support piping systems with loops, bends, expansion joints and/or flexible connectors as required for flexibility, to accommodate expansion and contraction of piping due to temperature changes in the contained fluids and in the surrounding space, and to minimize the transmission of vibration to the building structure.

E. Provide unions in the lines assembled with screwed and soldered fittings, at points of connection to equipment, and elsewhere as indicated or required to permit proper connections to be made, or to permit valves, equipment items, etc. to be removed. Provide unions also in welded lines at connections to equipment where flanges are not provided. Provide insulating unions where ferrous material joins non-ferrous material.

F. In piping systems assembled by welding, use factory-fabricated welding fittings of the same material and the same schedule or weight as the piping in which they are installed, except that branches or take-offs of sizes not exceeding 2/3 of the nominal diameter of the mains may be made with Bonney Weldolets or Threadolets. Mitering of pipe to form elbows, notching of straight runs to form tees, and any similar construction will not be permitted.

G. In general, use listed materials in fabricating the various piping systems. The method of assembly may be varied only to meet special conditions where it is impossible to comply with the specified method of joining piping. Where special classes of piping are involved and are not listed, request exact instructions as to the class of material involved and the method of fabricating it before ordering materials.

3.2 FLASHING

A. Flash around all pipes passing through the roof with sheet lead not less than 4 lbs. per square foot, built a minimum of 8" in all directions from the outside of the pipe into the waterproofing. Flashing shall be run up the pipe and turned over into the pipe cavity. Flashing at roof drains shall be 36" square.

B. Pitch Pans: Small lines thru the roof shall be installed thru pitch pans. Pans shall be 18 gage galvanized, welded, 3" deep, 8" X 8" or larger, packed with lead wool and filled with pitch.

3.3 PIPE SLEEVES

A. Generally, where pipes pass through walls or floors except sewer pipes through floors on grade, pipe sleeves shall be used. The sizes of these sleeves shall be such as to permit readily the subsequent insertion of the pipes of the proper size. In the case of insulated lines, the diameter of the sleeves shall be approximately 1/2 inch greater than the outside diameter of the insulation.

B. The pipes passing through interior walls or floors shall pass through galvanized pipe sleeves. In walls, they shall finish flush with each finished surface. In pipe chases, they

shall extend 1-1/2 inches above the floor slab. The annular space between the pipe and sleeve in floor penetrations and fire rated wall penetrations shall be fire-sealed with fire resistive material equal to Dow Corning Silicone RTV Foam Penetration Seal.

C. The pipes passing through concrete beams or walls, and masonry exterior walls and through floors shall be provided with galvanized wrought iron pipe sleeves. Weld at least four No. 4 rods to each pipe sleeve to serve as an anchor as directed by the Architect. After the pipes are installed, in the case of pipes sleeving through exterior beams or walls and floors on grade, the Contractor shall fill the annular space between the pipe and its sleeve with mechanical interlocking synthetic rubber link equal to Link Seal. Contractor shall coordinate sleeve size to insure a watertight joint.

3.4 ESCUTCHEONS, CEILING PLATES

A. Except as otherwise noted, provide and install concealed hinge, chrome plated escutcheons or ceiling plates with spring catches around each pipe passing through any wall, floor, or ceiling in any space, except in underfloor and attic spaces. Plates shall be sized to fit snugly against the outside of the pipe, or against the outside of the insulation on lines which are insulated.

B. No floor plates will be required around the iron pipe sleeves on exterior walls.

3.5 INTERIOR TRENCHING

A. Trenches for underfloor lines inside the building shall be properly excavated, following in general the procedures set out for exterior lines. Where floors are to be poured over these lines, they shall be backfilled, tamped, and settled with water.

B. Where necessary to cut floors for installation of underfloor lines, the floor shall be saw cut and patched back to a flush and level condition.

C. All surplus materials removed in these trenching operations shall be disposed of as directed by the Architect.

3.6 PROTECTION OF UNDERGROUND PIPING

A. Underground steel piping shall be cleaned and primed with Humble "Rust-Ban" and wrapped with a double thickness of 3M Scotch "51" vinyl tape over pipe and fittings.

3.7 FABRICATION OF PIPE JOINTS

A. Copper Tubing: Cut tubing square and deburr. Clean insides of fittings and outsides of tubing with sand cloth before assembly. Exercise care to prevent annealing of fittings and hard drawn tubing. Make all joints with solid string or wire solder, using non-corrosive

paste flux of the proper type for each application. No cored solder will be permitted. Use 95-5 solder (95% tin, 5% antimony) or Silvabrite 100 solder (95.5% tin, 4% copper, .5% silver composition) for all copper tubing. Under no circumstances will solder with any lead content be permitted on the jobsite. Where flanges are shown or are required for connection to equipment, they shall be 150 psi flanges.

B. Welded Joints: Make all welded joints by the metallic arc process. Use base material conforming to ANSI B31.1 for welded pipe ASTM A106 and ASTM A53. Use filler material conforming to ASTM A233 and in accordance with ANSI B31.1. Machine the ends of the material to be joined or gas cut. Make the cut smooth in order that good fit can be made, and a full penetration weld made. Use direct current for welding with the electrode positive. Limit the depth of deposit to 1/8" per pass. Remove all slag or flux remaining on any bead of welding before laying down the next successive bead of welding. Remove any cracks or blow holes that appear on the surface of any bead of welding by chipping or grinding before depositing the next successive bead of welding.

C. Solvent Weld Plastic Joints: Solvent welded according to manufacturer’s instructions.

D. Testing:

1. The Contractor shall have a minimum of 10 percent of all welds made by each welder examined and inspected by radiography. If a faulty weld is discovered, the Contractor shall perform radiographic inspection on all welds made by that welder. Any faulty welds shall be repaired and reinspected at the Contractor's expense.
2. The system shall be hydrostatically tested at 1.5 times the design pressure, as specified in Chapter VI ASME Code B31.1-1986 for Power Piping, and carefully checked for leaks. After leaks are repaired, retest system; repeat repair and test until proved tight. Equipment shall be isolated from hydrostatic testing of piping.
3. Welds which cannot be hydrostatically tested, e.g., branch connections made to existing piping, shall be radiographed per Chapter VI, ASME Code B31.1-1986 at Contractor's expense. The Owner at his option may allow visual inspection of these welds in lieu of radiographs.

3.8 REVISIONS AND RELOCATION OF EXISTING SYSTEMS

A. Where conflicts occur between the new work and the existing piping systems which cannot be resolved, the Contractor shall relocate the existing piping system. Relocated

positions of piping shall be tested for new work. All piping systems shall be free from leaks.

3.9 REPAIR OF LEAKS

A. All leaks in piping systems shall be corrected as follows:

1. Repair leaks in solder joints by remaking the joint; no soldering or brazing over existing joints will be permitted.
2. Repair leaks in screwed joints by tightening the joint; remake the joint if the tightening fails to stop the leak.
3. Leaks in caulked joints may be stopped by additional caulking of the joint; but if that fails, remake the joint.
4. Repair leaks in welded joints by removing the defective weld completely through the base metal and grind smooth. Re-weld, accomplishing 100% penetration of the base metal. The repair weld should in no case be less than 4" in length.

B. When any defect is repaired, retest that section of the system.

3.10 HANDLING OF MATERIAL

A. Hauling: All materials furnished by the Contractor shall be delivered and distributed at the site by the Contractor.

B. Loading and Unloading: Pipe, fittings, valves, and accessories shall be loaded or unloaded by lifting with hoists or skidding so as to avoid shock or damage. Under no circumstances shall such materials be dropped. Pipe handled on skidways shall not be skidded or rolled against pipe already on the ground. Each piece shall be unloaded opposite or near the place where it is to be installed. No material shall be unloaded where it will block any road, drive, building entrance, or walkway or where it will be a hazard to safe vehicular or pedestrian traffic.

C. Care of Pipe Coating and Lining: Pipe shall be so handled that the coating and lining shall not be damaged. If, however, any part of the coating or lining is damaged, the repair shall be made by the Contractor at his expense. If satisfactory repair cannot be made, the Contractor shall replace the damaged pipe.

3.11 ALIGNMENT AND GRADES

A. General: All pipe shall be laid and maintained to the required lines and grades with fittings, valves, at the required locations; spigots centered in bells; and all valve stems plumb. All pipe shall be installed straight and true to line.

B. Deviations Occasioned by Other Structures: Whenever obstructions not shown on the plans are encountered during the progress of the work, the lines and/or grades shall be adjusted so to not interfere with existing obstructions.

END OF SECTION 233000

SECTION 233800 - MARKING AND IDENTIFICATION

PART 1 - GENERAL

1.1 NOTE

A. Drawings, General Conditions of the Contract for Construction, Supplementary Conditions and Division 1 - General Requirements apply to Work of this Section.

1.2 SUBMITTALS

A. Submit manufacturer's data on all materials.

1.3 SCOPE

A. This section applies to piping systems used to transport gases, liquids or semi-liquids. The term "piping systems", includes pipes, fittings, valves and pipe coverings located either inside or outside the buildings. This identification scheme does not apply to piping systems buried in the ground.

1.4 REFERENCES

A. Occupational Safety and Health Standards - Part 1910.144.

B. Scheme for the Identification of Piping Systems - ANSI A 13.1

C. Safety Color Code for Marking Physical Hazards - ANSI 253.1

1.5 METHOD OF IDENTIFICATION

A. The primary identification of a piping system shall be made by a positive identification of the material content of the system by lettered legend, giving the name of the content in full or abbreviated form. This mark shall be conspicuously placed at frequent intervals on straight runs, close to all valves, at changes of direction and where pipes pass through walls, floors or ceilings. Arrows shall be used to indicate direction of flow.

B. This identifying mark shall be supplemented by the use of a color code which will indicate the nature of the material carried in the system. Piping systems shall be placed, by the nature of their contents, in one of the basic groups listed below. Each group is assigned a predominant color range as noted.

C. The entire exposed length of the piping system shall be painted by its proper color code to identify the system. Markers shall be painted on using stencils. Specialties shall be painted as specified for piping.

D. Markers shall be placed on piping at each connection to an item of equipment, at each pump, and on each drop to an outlet. Markers shall be placed on each run of piping at intervals not exceeding 50 feet where exposed in a room and 25 feet when installed above removable ceilings, except that no line shall enter a room without being identified therein. Markers on lines above removable ceilings shall be applied on the undersides of the lines and ducts and in other areas shall be applied to be most visible. Also supply directional flow indicators adjacent to identification markers similarly color coded and sized.

E. Size of Identification:

Outside Diameter	Size of Legend of Pipe or Covering Letters (" Height)
3/4 to 1-1/4	1/2
1-1/2 to 2	3/4
2-1/2 to 6	1-1/4
8 to 10	2-1/2
Over 10	3-1/2

F. Colors: Exact colors shall conform to Owners Piping Identification Code. All numbers are PITTSBURGH:

Piping	Color
Steam - 100 PSI	Safety Yellow - 6-264
Steam - 40 PSI	Safety Yellow - 6-264
Steam - 15 PSI	Safety Yellow - 6-264
Condensate - High Pressure	Sunset Orange - 54-124
Condensate - Low Pressure	Sunset Orange - 54-124
Condensate - Pump Return	Sunset Orange - 54-124
Ducts - Supply and Return	Safety Orange - 6-259
Hot and Chilled Water Supply & Return	Spanish Blue - 1-346
Waste and Vent	Flat Black - 54-198
Cold Water	Vista Green - 6-256
Hot Water	Rose Coral - 15P-27
Fire Lines & Gas (Nat.)	Safety Red - 6-261
Air Lines	Autumn Brown - 54-126

Equipment	
Pumps H & CH Water	Seal Brown - 1-344
Converter	Rose Coral - 15P-27
A.H. Unit, Generator	Touch up as required
H.W. Storage Tank	Rose Coral - 15 P 27
Sump Pump, Water Pumps	Safety Blue - 6-262
Controls Equipment	Powder Blue - 4P-55
Copper Pipe	Polish and lacquer
Electrical Materials	Grey
Vacuum Lines	Reef Brown - 95-6 (Color Guild)
Gas (Natural)	Safety Red - 6-261

1.6 IDENTIFICATION

A. The Contractor shall provide and install, on each valve and cock which he installs, a Seton P-250 tag with depressed, black filled numbers and letters identifying the service by letters and the number of the valve. Attach these to the handles of the valves and cocks using meter seals, approved brass S hooks, or heavy copper clad annealed iron wire.

B. Furnish and install where directed a chart or directory listing the complete identification of every valve and cock. This chart shall designate class of service, and shall itemize the valve or cock identified, shall list its exact location, shall give its number, and shall be neatly typed and mounted under a glass pane in a suitable frame. These charts shall, in addition, list the various colors identifying the piping.

1.7 IDENTIFICATION OF UNDERGROUND LINES

A. All lines installed underground shall have a 6" wide 0.004" thick color coded, permanent plastic tape buried above the pipe, approximately 12" below grade. The tape shall identify the pipe thus protected.

1.8 MARKING ACCESS DOORS AND PANELS

A. Lay-in Ceiling Panels: Use color coded thumb tacks neatly aligned in one corner of the panel to identify valves, fire dampers, smoke dampers, etc. The color code shall conform to the piping identification color code for valve access. The color shall be red for fire and smoke dampers.

B. Stencil 1/2" high letters on concealed access doors to identify fire and smoke dampers.

1.9 IDENTIFICATION AND LABELING

A. The Contractor shall make it possible for the personnel operating and maintaining the equipment and systems in this project to readily identify the various pieces of equipment, valves, piping, etc., by marking them. All items of equipment such as fans, pumps, etc., shall be clearly marked using engraved nameplates as hereinafter specified. The item of equipment shall indicate the same number as shown on the drawings. For example, pumps will be identified as P-1, P-2, P-3, etc.; exhaust fans will be EF-1, EF-2, etc.; AC Units will be AC-1, AC-2, etc.

B. All items of mechanical and electrical equipment shall be identified by the attachment of engraved nameplates constructed from laminated phenolic plastic, at least 1/16" thick, 3-ply, with black surfaces and white core. Engraving shall be condensed gothic, at least 1/2" high, appropriately spaced. Nomenclature on the label shall include the name of the item, its mark number, area, space, or equipment served, and other pertinent information. Equipment to be labeled shall include but not be limited to the following:

1. VAV Boxes
2. Air Conditioning Control Panels and Switches
3. Exhaust and Return Air Fans
4. Miscellaneous - similar and/or related items

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION 233800

SECTION 234000 - AIR DISTRIBUTION

PART 1 - GENERAL

1.1 NOTE

A. Drawings, General Conditions of the Contract for Construction, Supplementary Conditions and Division 1 - General Requirements apply to Work of this Section.

1.2 SUBMITTALS

A. Submit manufacturer's data on all materials.

1.3 SCOPE

A. This section of the specifications comprises the furnishing of all labor, materials, transportation, tools and appliances and in performing all operations in connection with the installation of apparatus casing, ductwork, plenums, linings, air distribution devices, dampers and control devices, relief air vents, curbs and other materials and accessories as described herein and/or as shown on the accompanying drawings, or reasonably implied therefrom.

B. In addition, connect all air conditioning units, automatic dampers, filters and all other materials and install (and/or cooperate in the installation with other trades) those various items of equipment and materials.

C. Existing Double Duct VAV boxes are specified to be equipped with new DDC Box Controllers. In addition to this work, inlet conditions for all boxes shall be corrected to match the detail on the drawings, including a minimum straight duct sheet metal inlet to meet manufacturer’s recommendations. Include correction of inlet conditions on all boxes to satisfy the detail shown on the drawings.

PART 2 - PRODUCTS

2.1 LOW PRESSURE DUCTWORK

A. Except as otherwise specified herein, in other sections of the specifications, and/or noted on the drawings, low-pressure ducts shall be constructed of galvanized steel sheets in accordance with the recommended construction for low pressure ducts insofar as gauges of metal to be used, bracing of joints and joint construction as established in the latest edition of the ASHRAE HANDBOOK.

B. Duct construction details shall conform to "HVAC Duct Construction Standards", 3rd Edition, (2015) published by the Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA). Refer to the fan schedules (TSP) for system pressures. Construction shall be suitable for actual duct system pressures.

C. Make square elbows where shown or required, with double thickness factory-fabricated turning vanes. Make all other changes in direction with rounded elbows having a centerline radius equal to 1-1/2 times the width of the duct in the plane of the bend.

D. Make transformations in duct shape or dimension with gradual slopes on all sides. Make increases in dimensions in the direction of airflow, with a maximum slope of 1" in 7" on any side. Make decreases in dimensions in the direction of air flow preferably with a slope of 1" in 7" on any side, but with a maximum slope of 1" in 4" where conditions necessitate.

E. Ducts shall be routed in conjunction with pipes, electrical conduits, ceiling hangers, etc. so as to avoid interferences insofar as possible. Where duct penetrations are unavoidable, provide streamline shaped sleeves around such material penetrations, made airtight at duct surfaces, except that such sleeves are not required at tie rods. Where obstructions are of a size to exceed 10% of the duct area, the duct shall be transformed to maintain the same duct area.

2.2 DUCT CONSTRUCTION TEST

A. A trial leak test, as specified herein, shall be made after installation of the first section of each type of ductwork to demonstrate adequacy of the construction details. All testing shall be done in the presence of the Architect.

B. Each test section shall incorporate at least five transverse joints and all typical fittings.

C. Drawings showing all construction details of test sections, test procedures and instrumentation, and test results shall be submitted for record purposes. No additional ductwork shall be installed until the trial test installation described above has been approved.

D. Low pressure duct shall be tested at 3" w.c. Construction of low-pressure systems shall be inherently airtight and leakage shall be of a sufficiently low magnitude as to be inaudible in quiet ambient and not detectable by sense of feel.

2.3 DUCT LINER

A. Note that internal sizes are shown on the drawings.

B. Return Air Transfer grilles and exposed supply duct shall be lined.

C. Conditioned Spaces:

1. The listed ducts shall be lined to a thickness of 1" with Johns-Manville "Permacote Linacoustic" mat faced duct liner, or equal duct liner coated with immobilized antimicrobial impregnated acrylic surface coating on one side.
2. Duct liner shall have an average thermal conductivity of .25 btu-in./sq. ft.-degree F. at a mean temperature of 75 F.

D. Unconditioned Spaces:

1. The listed ducts shall be lined to a thickness of 1-1/2" with Johns-Manville "Permacote Linacoustic" mat faced duct liner, or equal duct liner coated with immobilized antimicrobial impregnated acrylic surface coating on one side.
2. Duct liner shall have an average thermal conductivity of .20 btu-in./sq. ft.-degree F. at a mean temperature of 75 F.
3. Duct liner shall comply with ASTM C1071 with an NRC not less than 0.70 as tested per ASTM C423.
4. The duct liner shall be applied in accordance with the manufacturer's recommendations with the coated side away from the metal, using weld pins or adhesive Tuffbond and adhesive type metal clips, Gemco, or equal, of the type which do not protrude through the duct. The size of the ducts indicated are actual internal sizes and the sheet metal sizes shall be 2" greater in both dimensions to accommodate the lining. No voids are permitted.
5. Use 100% adhesive coverage and clips at the rate as specified by SMACNA.

2.4 DUCT SEALER

A. All supply air ductwork from the air unit to the terminal units shall be sealed to provide airtight construction. Metal surfaces to be joined shall be clean, dry and free of dirt or grease. Apply a heavy coat of Foster 32-19, Childers CP-146 or Kingco Seal-Rite 18-120 water based, non fibrated duct sealant to the interior metal surface of the slip joint, then interlock into place metal duct sections. Apply a heavy coat of duct sealant to the exterior metal surface duct joint, making sure any voids are filled to secure a continuous air pressure sealant.

B. Allow sealant to dry a minimum of 48 hours before pressurizing system.

2.5 HIGH PRESSURE DUCTS

A. This ductwork shall be defined as that between the discharge of the supply fan and pressure reducing terminal boxes. This work shall be provided and installed as shown and as specified hereinafter.

B. This ductwork shall be round in cross-section, flat oval or rectangular as shown on the drawings. It shall be constructed according to the latest edition of the ASHRAE HANDBOOK. Duct construction details shall be in accordance with the "High Pressure Duct Standard, 3rd Edition", published by the Sheet Metal and Air Conditioning Contractors National Association Inc. except as may be abridged herein.

C. All job-constructed ducts shall be made with longitudinal joints butted and welded. Round ducts 48" in diameter and smaller and all flat oval ducts shall be factory fabricated spirally wound conduit made from zinc coated steel strips. All such ducts shall be delivered in standard lengths and shall be cut to proper length at the site by power saw to insure proper fit and square alignment.

D. Fittings used on round or flat oval ducts shall be shop fabricated by welding. Changes in direction shall be made with mitered fittings of at least 3 sections; 90-degree elbows shall contain not less than five sections. Branch takeoffs shall be at 45 degree, except where indicated on the drawings they may be 90-degree conical taps. The run of a conical take-off shall be not less than the diameter of the branch which it serves. This contractor shall furnish for review drawings of fittings which he proposes to use and shall not proceed with fabrication until review by the Architect.

E. A high degree of dimensional accuracy is required in both conduit and fittings in order that the installation may be strong, rigid, and within allowable limits of air leakage. Inside diameter of conduits when checked with ring gages shall show a variation from nominal diameter of not more than 0.030". Fittings shall be provided with male connections and, when checked with ring gages, shall show a variation from nominal outside diameter of not more than 0.015 inch.

F. Transitions shall be all welded construction. In any required rectangular ells, provide Airsan "Acoustiturn" double thick acoustical turning vanes.

G. All high-pressure ducts having a dimension of 36" or greater shall be assembled using gasketed companion flanges.

H. All other joints between conduits and between conduits and fittings shall be made with "Hardcast" cement reinforced with self-tapping drill screws. Conduits shall be joined with couplings. Adjoining surfaces of fitting or coupling and conduit at each joint shall be thoroughly cleaned, and after receiving a uniform coat of cement shall be pressed together. Joints so formed shall be further strengthened by the use of hex head No. 7x12 self-tapping drill screws installed with a screw gun. Screws shall be equally spaced around the circumference and centered longitudinally on the joint. Use three screws per joint on conduit with diameters of 3" through 8" and space screws approximately 6" apart on conduit with diameters of 9" and over. Then seal the joint with "Hardcast" assembled using manufacturer's instructions.

I. It is essential that all high velocity ductwork be practically airtight. After erection in place, and before being insulated or connected to the air distribution units, each high velocity duct system shall be tested for leaks. For the test, each system shall be capped at all openings. Pressure test according to the SMACNA procedure, admitting air thru a precision orifice and using pressure taps and a manometer. Under this test there shall be no whistling leaks and the pressure drop across the orifice shall not exceed the pressure drop corresponding to 1% air loss according to SMACNA Tables of the design air quantity in that branch.

2.6 AIR CONTROL DEVICES

A. Manual dampers shall be installed as required to afford complete control of the airflow in the various duct systems. In rectangular supply ducts, a splitter damper shall be installed at each point where a branch is taken off and additional volume dampers shall be installed where shown or required to achieve the final air balance.

B. Splitter dampers and volume dampers of the "butterfly" type shall be constructed of 20 gauge galvanized steel riveted or welded to square operating rods. Dampers shall have bearings of brass, bronze or approved plastic in most instances. The length of any splitter damper blade shall be 1-1/2 times the width of the smaller split in the duct, but shall be not less than 12". Volume dampers of the butterfly type shall be used only in cases where neither dimension of the damper exceed 18". The metal used shall match that of duct system containing the damper in each case. Use special metals for damper rods and bearings as required to resist corrosion.

C. In cases where either dimension of the smaller branch duct exceeds 24", volume dampers shall be of the opposed blade type with blades linked together and controlled from a single point. They shall be constructed of No. 16 gauge steel either galvanized or with a baked enamel finish. Dampers shall have brass, bronze or approved plastic sleeve bearings. Blades shall be not more than 12" in width and shall be opposed acting, and those for automatic dampers shall be fitted with felts to insure tight closure. Felts shall be both glued and riveted to the damper blades. Blades shall be mounted in suitable band or angle iron frames strongly braced to insure rigidity.

D. Each splitter or volume damper, unless specified for automatic operation, shall be fitted with an adjusting device having a locking mechanism. Wherever the ducts are rendered inaccessible behind non-removable ceilings or furrings, or other construction that is not easily removable to permit access to the ducts, the devices shall be equal to Young Regulator Co. No. 896 concealed air split regulators. On exposed or easily accessible ducts the adjusting devices shall be equal to Young No. 1 or No. 900 and shall be fastened to the ducts.

E. Damper rods and operators on insulated ducts shall have extended rods and stand off brackets.

2.7 PLENUMS

A. The Contractor shall fabricate and install all sheet metal plenums. Plenums shall be constructed and insulated as specified for "Low Pressure Ductwork." In addition as a minimum requirement, plenums shall be braced with 1-1/2 by 10 gauge angles 24" on center, all sides. When plenums are mounted on the floor there shall be an additional angle around the plenum secured to the floor. Caulk all seams air and water tight.

B. There shall be at least one door in each plenum 18" by 48" with two latches, 12" square Airsan Ductport, piano hinge, and gasket. All plenum doors shall be double metal clad with 1" thick internal insulation. Provide two Ventlock series 300 latches on each door.

2.8 FLEXIBLE DUCT

A. Flexible ducts shall be used for connecting air terminal devices in high pressure systems, or for connecting air distribution devices in low pressure duct systems. Generally, flex duct shall not exceed 3'0" in length or have more than 90 degree of bend. At each vertical elbow, provide and install a FlexRIGHT or equal durable elbow support. Flexible duct shall be a factory-fabricated assembly consisting of an inner sleeve, insulation and an

outer moisture barrier. The inner sleeve shall be constructed of a continuous vinyl-coated spring steel wire helix fused to a continuous layer of fiberglass impregnated and coated with vinyl. A 1-1/4 inch thick insulating blanket of fiber glass wool shall encase the inner sleeve and be sheathed with an outer moisture barrier of a reinforced Mylar or neoprene laminate of low permeability. The flexible duct shall be rated for a maximum working velocity of 6000 FPM and shall be listed by the Underwriters' Laboratories under their UL-181 standards as a Class 1 duct and shall comply with NFPA Standard #90A. The flexible duct shall be Thermaflex M-KC for high pressure and Thermaflex M-KE for low-pressure application.

2.9 FLEXIBLE CONNECTIONS

A. Provide sound isolating flexible connections between connecting ducts and the inlet and outlet of each fan. These connections shall in each case be long enough to permit a minimum separation of 3" between the duct and the fan or unit housing with at least 1" slack in the flexible material itself.

B. The material shall be of a vinyl coated woven nylon/polyester blend base fabric, 22 oz. per square yard, meeting NFPA 90A and B for flame spread and smoke developed. It shall be fire resistant, waterproof and mildew-resistant. The material shall be equal to Excelon Fabric as manufactured by Duro-Dyne.

2.10 ROUND DUCT TAPS

A. Provide zero leak press on fitting that is constructed with fully welded seams and has elastomer bushings to accompany damper hardware. Fittings are to be equipped with an adjustable spring loaded locking mechanism standoff. Approved manufacturers – Elgen Manufacturing.

2.11 SMOKE DAMPERS

A. Smoke dampers shall be installed in each duct penetrating a smoke partition. Smoke dampers shall each be motorized fire dampers, Ruskin Type FB90ASM, Class II, DCFM leakage @ 1"SP. Construction shall be in accordance with NFPA 90A. The smoke dampers shall close on a signal from the fire alarm system or the operation of a smoke detector. Provide access doors with ductports in the duct and a ceiling access door at each smoke damper for servicing the damper, motor, and smoke detector. A UL label is required on each smoke damper.

2.12 FIRE DAMPERS

A. Weighted fire dampers having bronze bearings and held open by fusible links shall be constructed and installed in accordance with the recommendations of the National Fire Protection Association as published in NFPA Bulletin 90A and applicable ordinances and the Building Code. All fire dampers shall have Underwriters' Laboratory labels.

B. Specifically, fire dampers shall be provided at the points indicated on the drawings, where a duct penetrates a fire rated partition and where a duct penetrates the roof, ceiling, floor or other areas requiring a fire rated separation. They shall also be installed at any other location as required by applicable codes. Provide access panels in the duct and access doors in the ceiling or wall to service and test the damper. Access doors with vision panes shall be furnished with wire glass.

C. Furnish fire dampers with fusible links rated for 160 degrees F unless indicated otherwise. Fire dampers shall be constructed of galvanized steel and rated at 1-1/2 hours for partitions and floors rated up to 2 hours, and 3 hour rating for use in partitions and floors rated up to 4 hours unless noted otherwise. Blades shall be of the interlocking type, those in high pressure duct shall be 100% free area and out of the air stream. Fire dampers shall be suitable for either horizontal or vertical mounting as required and shall be furnished with factory fabricated sleeve minimum of two gauges heavier than connecting ductwork.

D. Fire dampers in low-pressure duct shall be equal to Action Air, Inc. Model 150A. Fire dampers in ceiling air distribution outlets shall be equal to Action Air, Inc. Model 400.

2.13 FIRE/SMOKE DAMPER

A. Furnish and install a combination fire/smoke damper in all ducts penetrating fire/smoke partitions. Each combination fire and smoke damper shall meet all requirements specified elsewhere for fire dampers and additionally shall include an operating shaft which, when rotated 90 degrees, causes damper to operate between closed and open. Operating shaft and damper combination shall be suitable for linking to and operation by a damper operator. Combination fire/smoke dampers shall be Ruskin type FSD-36, Class II, 250 deg. F., 10 CFM/SF leakage @ 1"SP for low pressure applications and Ruskin type FSD-60, Class I, airfoil blade, 4 CFM/SF @ 1"SP for high pressure applications.

B. Each combination fire/smoke damper shall be furnished complete with factory sleeve and damper operator factory installed on exterior of sleeve and properly linked to damper operating shaft. Actuator shall be of the spring return fail closed type that will close damper upon power interruption. Damper operators shall be UL listed as fire damper operators and bear the UL label for such. Blade edge seals shall be silicone rubber and galvanized steel mechanically locked into blade edge (adhesive or clip-on seals not acceptable).

C. The smoke damper shall close on a signal from the fire alarm system or from the operator of a smoke detector.

D. Provide access doors with ductports in the duct and a ceiling access door if necessary for servicing the damper and actuator.

2.14 ACCESS PANEL

A. Access doors of sufficient size shall be installed in ducts to permit servicing of contained equipment including fire extinguishing equipment, dampers, etc. Where those panels are in insulated ducts, they shall be double wall panels with material to match the lining and of the same thickness. In uninsulated ducts they shall be single wall construction. All access panels shall have No. 310 Ventlock catches and pulls, No. 260 hinges and No. 390 gaskets.

B. Where access panels are not exposed or readily accessible above removable ceilings, provide access doors in the general construction.

2.15 AIR DISTRIBUTION DEVICES

A. Furnish and install all grilles, registers, and diffusers for every purpose. Refer to the tabulation on the drawings for types, sizes and accessories.

B. All grilles, registers, and diffusers located in the ceiling shall be factory finished in OFF-WHITE. Door grilles shall be factory finished in baked enamel medium birch tan. All other grilles and registers shall be factory primed and spray painted 2 coats on the job. All grilles and registers shall be installed with tamperproof screws and shall be secured to the duct with a minimum of four screws.

C. Where perforated supply grilles are scheduled, they shall be of the type with adjustable curved blades in the neck of the diffusers. Other types are not acceptable.

D. Air distribution devices as manufactured by Barber Colman, Titus, Tuttle and Bailey, Metal-Aire or Krueger will be acceptable.

2.16 FLASHING

A. Where the contractor installs ducts or piping through the roof, he shall flash and counterflash them into the roof construction to the satisfaction of the Architect. All such flashing shall be constructed of copper bearing galvanized steel sheets.

2.17 DOUBLE DUCT VAV BOXES (AIR VALVES) - NEW

A. The air valves shall be of the dual duct or single duct type and shall be provided in a complete package with control damper, electric actuator and variable air volume control assembly, etc. The damper shall be housed in a 22 gauge galvanized steel housing of leak resistant construction with mechanical seal and with coated 1" thick insulation to resist erosion and to meet NFPA 90A and 90B requirements. The air valves shall be arranged either normally open or closed to meet the requirements of the hot or cold duct in which they are to be installed. Access to the damper and linkage shall be either through the outlet or through an access door. Scribe end of damper rod to indicate damper position. Secure damper linkage with indents and screws or through pins.

B. The electronic controllers shall provide the characteristics of pressure independence so that the minimum and/or maximum CFM requirements of each space served will be obtained throughout the entire operating range of the air valve, regardless of the pressure changes in the system. Further the reset span of the electronic volume controller shall be adjustable for maximum and minimum air flow rate settings with fixed 2 deg. F. temperature range.

C. The Temperature Regulation Sub Contractor shall provide the electric actuators and deliver them to the unit manufacturer for his assembly of the air valve package. See Temperature Regulation Section. At the Contractor's option compatible actuators of other manufacture may be supplied with the terminals.

D. Where two air valves (hot and cold) serve a single space through a single thermostat, they shall have the capability to operate either with a dead band between the two control modes or with mixing at the junction of the two modes where minimum air CFM is specified. Above the minimum CFM there shall be no mixing.

E. Air valves shall be Titus as scheduled. These air valves have a round inlet for hot and cold ducts.

F. The new either single duct (cold) or dual duct (hot and cold) air valves shall be installed in accordance with the manufacturer's instructions. A minimum of 1-1/2 diameters of

straight round duct is required ahead of the terminal unit so that the static pressure sensor of the pressure independent control will function properly. Any turns or flexible duct will be ahead of the straight run. Maximum length of flexible ducts shall be 18".

2.18 DOUBLE DUCT VAV BOXES (AIR VALVES) - EXISTING

A. The existing air valves are of the dual duct type. Remove the existing hot and cold duct actuators, the pneumatic box controller and the pneumatic thermostat. Reuse the air valve and flow cross at the inlet of each valve. Provide and install in the field new electric/electronic damper actuators, VAV box controllers and network thermostats for each box. Provide discharge air sensors for all existing boxes. The air valves shall be arranged normally open. Access to the damper and linkage shall be either through the outlet or through an access door. Scribe end of damper rod to indicate damper position. Secure damper linkage with indents and screws or through pins.

B. The electronic controllers shall provide the characteristics of pressure independence so that the minimum and/or maximum CFM requirements of each space served will be obtained throughout the entire operating range of the air valve, regardless of the pressure changes in the system. Further the reset span of the electronic volume controller shall be adjustable for maximum and minimum air flow rate settings with fixed 2 deg. F. temperature range. Map all DDC Box controllers into the Johnson Metasys system through a gateway and provide color graphics for all box controllers, showing all available functions on the color graphics.

C. The Temperature Regulation Sub Contractor shall provide the electric actuators, box controllers and thermostats and shall field install these devices on the boxes in place where they are to be reused. See Temperature Regulation Section.

D. Where two air valves (hot and cold) serve a single space through a single thermostat, they shall have the capability to operate either with a dead band between the two control modes or with mixing at the junction of the two modes where minimum air CFM is specified. Above the minimum CFM there shall be no mixing. Refer to the control diagram on the drawings.

E. For boxes to be reused, correct kinked flex duct at inlets by installing straight sheet metal leading into the flow cross, as recommended by the VAV box manufacturer, and as shown on the detail on the drawings.

F. The existing air valves are scheduled. These air valves have a round inlet for hot and cold ducts.

PART 3 - EXECUTION

Not Used

END OF SECTION 234000

SECTION 235000 - HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 NOTE

A. Drawings, General Conditions of the Contract for Construction, Supplementary Conditions and Division 1 - General Requirements apply to Work of this Section.

1.2 SUBMITTALS

A. Submit manufacturer's data on all materials.

1.3 SCOPE

A. The Contractor for the work covered by each section of the specifications shall furnish and install all hangers, supports and isolation required by pipe or equipment included in this work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials shall be provided for the support of all piping and equipment. The following tabulation lists materials suitable for this duty. Equal materials manufactured by Fee and Mason, Carpenter-Patterson, Grinnell or Modern will be considered.

MATERIAL	SERVICE	FEE AND MASON CAT.
Hanger	Copper Tubing 4" and Larger	364 copper plated
Hanger	Copper Tubing 3" and smaller	361 copper plated
Hanger	Steel Lines 3" and smaller	215 or 199
Hanger	Steel lines 4" and larger	239
Hanger	Outside Insulation-all lines	239
Hanger	Cast Iron Lines	239
Hanger	Plastic Pipe	108 + 109
Hanger	Refrigerant Pipe	102
Hanger	Glass Pipe	375
Wall Bracket	All	150, 151, or 155
Saddles	Steel Lines On Rollers	71, 1710, 1712, 172, 173
Conc. Inserts	New Construction	185
Rollers	Steel Piping	161, 272

Pipe Clamps	2" and Smaller	304
Pipe Clamps	3" and Larger	241
Pipe Rest	All	295 or 291
Exp Shield	Concrete	374
Beam Clamps	All	249, 254, 255, 282, 280
Adjuster	All	2381

2.2 HANGER RODS

A. All individually suspended horizontal pipes shall be supported by steel rods sized as follows:

Rod Diameter	Size of Steel Pipe or Copper Tube Supported	Size of Cast Iron Pipe Supported
3/8"	2-1/2" and smaller	3" and smaller
1/2"	3" and 4"	4" through 6"
5/8"	5" through 8"	8" through 10"
3/4"	10" and larger	12" and larger

2.3 HANGER SPACING

A. All hangers shall be so located as to properly support horizontal lines without appreciable sagging of these lines. The following table gives minimum spacing for copper, and steel lines, but hangers shall be more closely spaced where necessitated by conditions or the type of pipe involved or required by code.

Size of Line	Hanger Spacing in Feet
3/4" and smaller	5
1" through 1-1/2"	7
2" and larger	10
All cast iron lines	5 (Minimum two per joint)

PART 3 – EXECUTION

3.1 INSTALLATION OF SUPPORTS

A. All pipes shall be adequately supported. All piping shall be installed with due regard to expansion and contraction, and the type of hanger, method of support, location of supports, etc. shall be governed in part by this consideration. Transmission of vibration and noise shall also be considered and any special suspension with vibration dampeners required to minimize transmissions shall be used where specified or required.

B. All exposed vertical risers running near walls shall be supported from the walls. Each line shall have a minimum of 2 supports, not greater than 10’0” on centers, with the additional provision that there shall be a support near the top of the riser. All supports shall be aligned.

C. All vertical pipes shall be supported with riser clamps sized to fit the lines and to adequately support their weight. At the bases of lines, where required for proper supports, furnish and install anchor base fittings or other approved supports.

D. Where vertical lines run down to a point near the floor and a support is needed, they may be supported by means of a pipe leg welded to the pipe, extending down to the floor and terminating in a capped end resting on the floor.

E. Where pipes other than those specified hereinbefore, are running along walls, they shall be supported using hangers as described hereinbefore, but suspended from brackets bolted to the wall. Specially fabricated clips or U-braces may be used where commercially manufactured items are not available in the proper size.

F. Where pipes run under steel construction, use beam clamps on beams. Under steel joists, piping may be suspended from rods thru the bottom chord with washers and double nuts. On piping larger than 4”, verify the joist strength before installation.

G. Where multiple lines are run horizontally at the same elevations and grades, they may be supported on trapezes formed for sections of Unistrut, angle iron, or channels suspended on rods or pipes. Trapeze members, including the suspension rods, shall be properly sized for the number, size and loaded weight of the lines they are to support. Trapeze spacings shall be in accordance with the preceding table for the smallest line supported on or from the trapezes.

H. Perforated strap iron and wire will under no circumstances shall be acceptable as hanger material.

I. Hangers supporting insulated lines which are specified to be finished with a vapor seal shall be fitted outside the insulation. The insulation or horizontal lines shall be protected by low compression insulation shields. On all pipes the shields shall be Fee and Mason Fig. 81 or rolled 14 gauge galvanized. The shields on horizontal lines shall be positioned so that they encompass the bottom of the pipe and are centered on the hanger or support. On vertical lines there shall be two shields of the same type full encompassing the pipe

at each clamp. Shields shall be secured with a 3/4” wide lacquered steel band at each end.

J. Horizontal piping subject to expansion due to temperature above 180 degrees F shall be supported on roller hangers. Where the line is supported from overhead, hangers shall be Fee and Mason Fig. 272 with two locknuts on the hanger rod to allow for proper leveling of the line. Lines supported from elbow shall be supported using Fee and Mason Fig. 161 adjustable pipe roll stands set on and attached to support framing members. Roller hangers shall be sized to allow for increased sizes due to pipe covering.

K. On all insulated lines four inches and larger and where roller supports are used on piping systems, install pipe covering protective saddles so that the load of the pipe line will be transmitted directly to the rollers without damage to the insulation.

3.2 COOPERATION BETWEEN TRADES

A. Where pipes specified under different sections may possibly be racked on the same supporting structure, each trade shall cooperate with the others involved to properly locate the supporting members and shall furnish a proportionate share of the labor and materials involved in the installation.

B. Any other special hangers and supports shall be provided and installed as indicated on the drawings, specified elsewhere herein or required by conditions at the site.

3.3 DUCT HANGERS

A. All ductwork shall be supported in accordance with standards published by Sheet Metal and Air Conditioning Contractors National Association Inc.

END OF SECTION 235000

SECTION 236000 - INSULATION

PART 1 - GENERAL

1.1 NOTE

A. Drawings, General Conditions of the Contract for Construction, Supplementary Conditions and Division 1 - General Requirements apply to Work of this Section.

1.2 SUBMITTALS

A. Submit manufacturer's data on all materials.

1.3 SCOPE

A. This section of the specifications comprises the furnishing of all labor, materials, transportation, tools and appliances and in performing all operations in connection with the installation of thermal insulation, coverings, jackets, supports, shields, etc. as described herein and/or as shown on the accompanying drawings, or reasonably implied therefrom. All surfaces which may vary from the ambient temperature shall be insulated unless specifically accepted.

PART 2 - PRODUCTS

2.1 MATERIALS

A. In describing the various materials, application procedures, and finishes, each item will be described singularly, even though there may be a multiplicity of identical applications. Also, where the description is only general in nature, exact dimensions, arrangements and other data shall be determined by reference to plans, schedules, and details, including those provided by equipment manufacturers.

B. Where materials are described under other sections of the specifications and are pertinent to this section, they shall be installed hereunder as though they were repeated herein.

C. All insulation shall have composite fire and smoke hazard ratings as tested by procedure NFPA 225, not exceeding flame spread 25, smoke developed 50. Accessories such as adhesives, mastics, cement, tape, cloth, etc. shall have these same component ratings.

D. All materials installed under this section of the specifications shall be manufactured in the United States of America.

2.2 VAPOR BARRIER JACKETS

A. Factory-applied vapor-barrier jackets shall be laminated of flame resistant white kraft paper and .001-inch-thick aluminum foil reinforced with glass fiber fabric between the foil and the paper. The foil and paper shall be adhered with a flame-resistant latex adhesive.

B. Where specified, insulate valves and fittings with two fiberglass inserts and preformed Manville "Zeston" covers with taped seams.

C. Where metal jackets are specified, they shall be 0.016" thick No. 5005 tempered aluminum secured with machine drawn 0.020" stainless steel bands.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The installation of all thermal insulation shall be performed by a recognized firm regularly engaged in the insulation business, using skilled insulation mechanics and using insulation materials which are the product of reputable manufacturer of the materials, using any special materials as required by these specifications and by those published standards.

B. Any insulation which is not applied in a workmanlike manner will be rejected and replaced. All coverings shall be smooth, flush, dressed to line and tight. Mastic shall be neatly applied and tooled. The Architect reserves the right to reject any insulation whose appearance he deems unacceptable.

3.2 APPLICATION OF INSULATION

A. Apply insulation and pipe covering after all work has been tested, found to be tight and accepted as such by the Architect. Thoroughly clean and dry all surfaces to be covered.

B. Apply rigid insulation board on flat sheet metal surfaces with Foster No. 85-60 or Childers CP-127 adhesive and additionally secure with Graham pins or adhesive clips on 12" centers. No penetration of the metal will be permitted. Fill all joints with seam filler and strip with an open woven glass fabric tape. Trowel Foster No. 30-65 or Childers CP-34 vapor barrier coating over all joints and clips to a 1/8-inch thickness and wipe to eliminate pinholes.

C. On glass fiber pipe covering with factory-applied vapor-barrier jacket, lap the jacket on the longitudinal seams and seal with vapor barrier lap adhesive equal to Foster 85-60 or Childers CP-82 or use self-sealing lap. Tightly butt the ends and cover butt joints with a 4" wide band of vapor barrier jacket secured with the same adhesive.

D. Except where insulation is cloth jacketed, band all pipe insulation, following the completion of painting operations. Bands shall be aluminum not less than 3/4 inch wide. Space bands a maximum of 12" on centers, with three bands per section of covering. Where sections of insulation are overlapped as at flanges, apply a band at each of the overlapping sections and one on the basic line covering immediately adjacent to the end of the overlap. Provide bands also on each side of each valve, fitting, etc. and at the end terminal where the insulation is beveled off as specified herein. Also band the hanger shields on insulated cold lines with a band at each end of each shield.

E. Exclusions: No insulation shall be applied to:

1. The cooling leg at a steam trap--the piping from the scale pocket ahead of the trap to the line on the outlet of the union following the trap.
2. Expansion tanks.
3. Exposed chrome plated lines.

3.3 INSULATION ON EQUIPMENT AND PIPING SYSTEMS

A. The following describes materials, thicknesses and finishes for insulation and coverings. In the following, the word "exposed" shall apply to any line, duct, or other material or surface in any room above the lowest floor in any building unit, exterior to the building and above ground, and/or in equipment rooms; the word "concealed" shall apply to any line, duct, or other material or surface in other underfloor areas, ceiling spaces furrings and chases.

B. Also included in this section is the requirement for patching and repair of existing insulation where new connections are made.

1. Domestic Hot Water and Circulating Lines: Insulate with Manville "Micro-Lok APT 650" molded sectional glass fiber pipe covering with all-purpose jacket. Insulation shall be 1” for lines 1.5 inches and smaller. Insulation shall be 1.5” thick for larger lines. Insulate valves and fittings with Manville preformed "Zeston" PVC covers over fiberglass insulation.
2. Domestic Cold Water Lines: All cold water lines throughout with those exceptions noted hereinbefore, shall be insulated with 1" thick Manville "Micro-lok APT 650" molded glass fiber pipe covering with factory applied vapor barrier jacket. Insulate valves and fittings with Manville preformed "Zeston" PVC covers over fiberglass insulation.

3. Refrigeration Suction Piping: 1" Manville Type II "Aerotube" threaded onto piping during fabrication and sealed with adhesive. In VRF systems, both refrigerant lines shall be insulated as specified. All exterior refrigerant lines shall receive an additional covering of 0.016" thick No. 5005 tempered aluminum secured with machine drawn 0.020" stainless steel bands.
4. Drain Lines, including condensate drain lines: 3/8" thick Armaflex. Insulation may be slit flange type or threaded on during fabrication.
5. Horizontal Storm Drains and Downspouts: Insulate entirely as specified for domestic cold water lines.
6. Roof Drains: Insulate bodies of roof drain with one coat insulating cement to thickness of adjacent covering and cover with vapor barrier jacket of kraft paper and aluminum foil with glass fiber reinforcing fabric. Hubs shall be covered by building up layers of insulation until they are covered. The insulation shall overlap the adjacent insulation by a minimum of 2", bevel the ends and seal with glass fiber reinforced vapor barrier asphaltic adhesive.
7. Fire Barrier Wrap: For PVC or other Plastic Piping installed in Return Air Plenum spaces for all waste, vent, water, roof drainage, and other piping constructed of PVC or other plastic and installed in plenum spaces, provide and install fire barrier wrap for complete coverage. Fire barrier wrap shall be equal to 3M Fire Barrier Plenum Wrap 5A fire resistant wrap consisting of an inorganic blanket encapsulated with a scrim-reinforced foil. The assembly shall provide a flexible, non-combustible enclosure for piping in return air plenum as tested to UL 910. The product shall contain no asbestos. Wrap shall be tested in accordance with the following standards - ASTM C 411, ASTM C 518, ASTM E 84, ASTM E 136 AND UL910. Surface burning characteristics per ASTM E84 shall be Flame Spread - 0 and Smoke Developed - 0. Wrap shall be 1/2" minimum thickness. Wrap shall be installed in strict accordance with the manufacturer's installation instructions.
8. Duct Insulation: Refer to Section 'AIR DISTRIBUTION' for duct liner specification. Return air transfer ducts and exposed supply ducts shall be lined.

9. Concealed High Pressure Ducts:
    a. Insulate the round cold high pressure ducts with 0.75 lb. density, 2" thick Manville "Microlite R Series" glass fiber flexible insulation having a factory applied FSKL vapor barrier jacket.
    b. This insulation shall be secured, vapor barrier side out, to sheet metal. On horizontal runs, lap top and bottom sheets over edges of side pieces. Butt joints tightly. Seal all joints, punctures, breaks and fasteners with two coats of Foster 85-20/85-60 or Childers CP-127 adhesive. Embed three-inch wide Glassfab membrane in adhesive between coats. Cover all joints, punctures and breaks with three-inch wide facing strip and Foster 30-65 or Childers CP-34 vapor barrier coating to prevent moisture ingress. Install with not more than 25% compression in accordance with manufacturer's installation instructions. Note that double wall duct need not be insulated.
    c. Insulate the warm high pressure supply duct same as described hereinbefore for cold high pressure supply duct, except that joints need not be vapor sealed. Cover all joints with three-inch wide facing strip.
    d. Insulate flat oval ducts as specified for round high pressure ducts except that adhesive clips or Graham pins 12" on centers shall be used to secure the insulation. Provide a cross-patch of glass fabric tape where each clip penetrates the vapor barrier. Trowel Foster No. 85-60 or Childers CP-127 vapor seal adhesive over all clips to a thickness of 1/8 inch and wipe to eliminate pinholes. Note that double wall duct shall not be insulated.
    e. Insulate rectangular high-pressure supply ducts with 1" thick, Manville "Spinglas No.814", 3 lb. density fiberglass, with FSK jacket applied with 100% adhesive coverage and graham pins 12" OCEW. Glasfab and mastic seal all joints and pin holes. Where ducts are exposed, cover with glass cloth.
10. Concealed Low Pressure Ducts:
    a. Insulate the supply air ducts with 0.75 lb. density, 2" thick Manville "Microlite R Series" glass fiber flexible insulation having a factory applied FSKL vapor barrier jacket.
    b. This insulation shall be secured, vapor barrier side out, to sheet metal. On horizontal runs, lap top and bottom sheets over edges of side pieces. Butt

joints tightly. Except on ducts handling warm air only, seal all joints, punctures, breaks and fasteners with two coats of Foster 30-65 or Childers CP-34 vapor barrier coating. Embed three inch wide Glassfab membrane in adhesive between coats. Install with not more than 25% compression in accordance with manufacturer's installation instructions.

c. Cover all joints, punctures and breaks with three-inch wide facing strip.

d. Ducts handling warm air only need not be vapor sealed.

END OF SECTION 236000

SECTION 237000 - EQUIPMENT

PART 1 - GENERAL

2.1 NOTE

A. Drawings, General Conditions of the Contract for Construction, Supplementary Conditions and Division 1 - General Requirements apply to Work of this Section.

2.2 SUBMITTALS

A. Submit manufacturer's data and shop drawings on all items specified.

2.3 SCOPE

A. This section of the specifications pertains to all labor, materials, equipment and service necessary for and incidental to the mechanical equipment as shown on the drawings and/or as specified herein.

B. This section requires the furnishing of all equipment specified and/or shown on the drawings. Equipment referred to singularly shall mean each item, and the total number of items shown or specified shall be furnished. All equipment shall be manufactured in the USA.

C. All appurtenances and auxiliary equipment necessary to the function of any specified item of equipment shall be furnished with the item of equipment, whether specifically mentioned or not. Each item of equipment shall perform the function for which it is intended, and all work necessary to provide a complete functional system shall be provided.

D. This specification requires that all items of equipment be completely installed, finally connected, tested and placed in service.

E. It shall be the responsibility of the Contractor to verify all requirements of the equipment and the contract and certify with the submittal of the shop drawings that all requirements have been met, including:

1. Space requirements
2. Electrical requirements (voltage, phase, wires - no. and size)
3. Capacities
4. Clearance for maintenance
5. Quality

6. Quantity

PART 2 - PRODUCTS

2.1 MOTORS

A. Motors shall be furnished for all motor driven equipment. Motors with special operating conditions such as multiple speed or in hazardous locations shall be as specified under the equipment served. General service motors driving through flexible couplings or belts shall conform to the following requirements:

1. Less than 1/6 HP: Split phase, 40 degree C ambient, dripproof or enclosed as required by exposure, with a service factor of 1.0. Provide with inherent thermal overload protection.
2. Fractional larger than 1/6 HP: Capacitor start, 40-degree C ambient, dripproof or enclosed as required by exposure, with a service factor of 1.0 or greater. Provide with inherent thermal overload protection.
3. Integral Horsepower, Single Phase: Capacitor type, 40-degree C ambient, dripproof or enclosed as required by exposure, with a service factor of 1.15.
4. Three Phase: High efficiency continuous duty squirrel cage type, 40 degree C ambient, dripproof or totally enclosed fan cooled as required by exposure with a service factor of 1.15. Power factor shall be 85% or greater. Motors shall be equal to Gould E-Plus.

2.2 MOTOR STARTERS

A. Except where starters are shown integral to motor control centers (see electrical drawings), the Division 23 Contractor shall furnish all motor starters (controllers) and control equipment for equipment specified under Division 23. The Contractor under this section of the specifications shall be responsible for coordinating starter sizes, characteristics, heater element sizes and all other details. All starters shall be combination starter/disconnect devices, and shall include control transformers, hand-off-auto switches, and pilot lights.

B. All individual starters shall be the product of a single manufacturer and submitted for review at the same time.

C. Where starters are specified with items of equipment, the starters shall be factory mounted and wired.

D. Magnetic Starters (Full Voltage): Starters shall be individual units, combination starter/molded case circuit breaker units, combination starter/fused disconnect switch units or combination starter/unfused disconnect switch units unless otherwise indicated.

E. Units shall be of General Electric, Square D, Westinghouse, Federal or Gould manufacture with the proper enclosures.

F. Provide pilot lights and either pushbutton stations or hand-off-automatic switches as required for the control of each item of equipment. Generally, pushbutton stations shall be used only where no interlock or remote functions are specified. Control devices shall be in the starter cover unless otherwise indicated.

G. Provide auxiliary contacts on starters to accomplish interlocks and control as specified. Starter disconnecting means shall have auxiliary contacts to disconnect all control circuits when the starter is disconnected.

H. Provide all three phase starters with solid state overloads which provide protection against single-phase events.

I. Equip each starter unit with a control power transformer, with 120-volt secondary, a secondary fuse in one leg and the other secondary leg grounded.

J. Manual Starters: Where manual starters are indicated, they shall consist of a horsepower rated on-off switch, or hand-off-auto switch with a pilot light and overload element(s) in the same enclosure. Where the starter is installed in public areas, it shall be in a recessed box with a stainless steel coverplate.

2.3 BELT GUARDS

A. Belt guards shall be provided for all belt driven equipment installed under this contract. Guards shall be rigidly constructed of 18-gauge sheet metal on angle iron frame, with fronts of expanded metal or 1/2-inch mesh hardware cloth. Guards shall be sized to permit belt tightening to the full extent of the motor slide rails. They shall be securely installed in such fashion as to permit ready removal for servicing of the protected drive. Guards shall have tach holes.

2.4 FANS

A. The fans indicated on the drawings shall be provided in accordance with the schedule on the drawings.

B. All v-belt drives shall be a variable pitch type and shall be so selected that the specified fan performance occurs at approximately the midpoint of the adjustable range. Motor

mounting shall be flexible to permit belt tightening. The static pressure tabulated in the schedule is for bidding purposes only. The fan shall be adjusted to achieve the air delivery specified and if changing of the motor and drive is required it shall be done at no increase in the contract.

C. Motor and Drive: The motor shall be open drip proof NEMA T frame design to meet horsepower and electrical requirements specified. The adjustable v-belt drive shall be selected for a 1.4 service factor based on motor horsepower and shall be factory set for the specified rpm. The motor shall be mounted for alignment and tensioning the belts. Conduit shall be flexible.

D. Provide isolators and flexible duct connections with each fan to limit the transmission of noise and vibration.

E. Fans shall be AMCA rated as scheduled.

F. Fans shall be furnished with backdraft dampers and disconnect.

G. Fans shall be statically and dynamically balanced.

H. Fans shall have factory-applied finish.

I. Fan motors 1/8 HP and larger shall be permanent capacitor start type.

J. Power Roof Ventilators:

1. All roof mounted exhaust fans shall be of the low silhouette type with fan wheels mounted horizontally. All fan housings shall be corrosion resistant construction. All fans shall be equipped with ball bearings, permanently lubricated. Fans shall be resiliently mounted.
2. Unless scheduled otherwise, all exhaust fans shall have backward inclined centrifugal wheels.
3. All fans shall have backdraft dampers and bird screens.
4. Refer to the drawings for special requirements.
5. Curbs shall be factory-fabricated and furnished with the unit.
6. Exhaust fans shall be as manufactured by Cook, Penn Ventilator, Jenn Aire Products Co. or Greenheck.

2.5 RARE BOOKS ROOM UNIT: Refer to 237100 – Rooftop Unit For Rare Books Room.

PART 3 - EXECUTION

Not Used

END OF SECTION 237000

SECTION 237100 – ROOFTOP UNIT FOR RARE BOOKS ROOM

PART 1 - GENERAL

1.1 GENERAL DESCRIPTION

A. This section includes the design, controls and installation requirements for packaged rooftop units / heat pumps / outdoor air handling units.

1.2 QUALITY ASSURANCE

A. Packaged air-cooled condenser and cold climate air-source heat pump units shall be certified in accordance with AHRI Standard 210/240 performance rating of unitary air-conditioning and air-source heat pump equipment.

B. Cold climate air-source heat pump heating performance shall be laboratory tested and verified down to zero degrees ambient.

C. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.

D. Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.

E. Unit shall be certified in accordance with ANSI Z21.47b/CSA 2.3b and ANSI Z83.8/CSA 2.6, Safety Standard Gas-Fired Furnaces.

F. Unit (Seasonal) Energy Efficiency Ratio, (SEER) EER, shall be equal to or greater than prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.

G. Unit shall be safety certified by ETL and be ETL US and ETL Canada listed. Unit nameplate shall include the ETL/ETL Canada label.

H. Unit shall comply with Chicago code requirements for an HVAC unit (with cooling and gas heat) (with cooling and electric heat) (with cooling) (with gas heat) (with electric heat) (without cooling or heating).

I. Unit cabinet construction shall be designed and manufactured to meet IBC 2009/2012 seismic standards.

J. Unit shall be IBC 2009/2012 seismically certified. Unit shall be certified through seismic analysis and shake testing in accordance with ASCE-7-05/7-10 and ICC-ES AC-156.

K. Unit shall be preapproved for California Office of Statewide Health Planning and Development (OSHPD) special seismic certification (OSP-0180-10).

1.3 SUBMITTALS

A. Product Data: Literature shall be provided that indicates dimensions, operating and shipping weights, capacities, ratings, fan performance, filter information, factory supplied accessories, electrical characteristics and connection requirements. Installation, Operation and Maintenance manual with startup requirements shall be provided.

B. Shop Drawings: Unit drawings shall be provided that indicate assembly, unit dimensions, construction details, clearances, and connection details. Computer generated fan curves for each fan shall be submitted with specific design operation point noted. Wiring diagram shall be provided with details for both power and control systems and differentiate between factory installed and field installed wiring.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Unit shall be shipped with doors bolted shut and outside air hood closed to prevent damage during transport and thereafter while in storage awaiting installation.

B. Follow Installation, Operation and Maintenance manual instructions for rigging, moving, and unloading the unit at its final location.

C. Unit shall be stored in a clean, dry place protected from construction traffic in accordance with the Installation, Operation and Maintenance manual.

1.5 WARRANTY

A. Manufacturer shall provide a “parts only” limited warranty for a period of 24 months from the date of original equipment shipment from the factory. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided manufacturer’s written instructions for installation, operation and maintenance have been followed. Warranty excludes parts associated with routine maintenance, such as belts and air filters.

B. Manufacturer shall provide a “parts only” limited warranty for a period of 60 months from the date of original equipment shipment from the factory. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided manufacturer’s written instructions for installation, operation and maintenance have been followed. Warranty excludes parts associated with routine maintenance, such as belts and air filters.

C. Manufacturer shall provide a “parts only” limited warranty for a period of 120 months from the date of original equipment shipment from the factory. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided manufacturer’s written instructions for installation, operation and maintenance have been followed. Warranty excludes parts associated with routine maintenance, such as belts and air filters.

1.6 START-UP REPAIR PROGRAM

A. Manufacturer shall provide start-up repair for a period of 12 months from the date of original equipment shipment from the factory. Program shall cover labor for material and workmanship that prove defective, within the specified warranty period, provided manufacturer’s written instructions for installation, operation and maintenance have been followed. Program excludes labor associated with routine maintenance, such as belt and air filter replacement.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Products shall be provided by the following manufacturers:
   1. AAON
   2. Substitute equipment may be considered for approval that includes at a minimum:
      a. R-454B refrigerant
      b. Direct drive supply fans
      c. Double wall cabinet construction
      d. Insulation with a minimum R-value of 13
      e. Stainless steel drain pans
      f. Hinged access doors with lockable handles
      g. Variable capacity compressor with 10-100% capacity
      h. Inverter driven variable speed compressor
      i. Cold climate air-source heat pump heating down to zero degrees ambient
      j. All other provisions of the specifications must be satisfactorily addressed

2.2 ROOFTOP UNITS

A. General Description:
   1. Packaged rooftop unit shall include compressor, evaporator coil, filters, supply fan, dampers, air-cooled condenser coil, condenser fan, water-cooled condenser,

reheat coil, gas heaters, electric heaters, hot water coil, steam coil, exhaust fan, energy recovery wheel (fixed plate heat exchanger) and unit controls.

2. Packaged cold climate air-source heat pump rooftop unit shall include variable speed compressor, evaporator coil, electronic expansion valve, reversing valve, filters, supply fans, dampers, air-cooled condenser coils, condenser fans, reheat coil, auxiliary dual fuel gas heaters, electric heaters, hot water coil, steam coil, exhaust fans, return fans, energy recovery wheels (fixed plate heat exchanger), and unit controls.
3. Outdoor air handling unit shall include filters, supply fan, dampers, chilled water coil, DX evaporator coil, gas heaters, electric heaters, hot water coil, steam coil, exhaust fan, energy recovery wheel (fixed plate heat exchanger) and unit controls.
4. Unit shall be factory assembled and tested including leak testing of the coils, pressure testing of the refrigeration circuit, and run testing of the completed unit. Run test report shall be supplied with the unit in the controls compartment's literature pocket.
5. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
6. Unit components shall be labeled, including pipe stub outs, refrigeration system components and electrical and controls components.
7. Estimated sound power levels (dB) shall be shown on the unit ratings sheet.
8. Installation, Operation and Maintenance manual shall be supplied within the unit.
9. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's access door.
10. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's access door.
11. Options: Unit shall be crated for overseas shipment. Crate shall be fabricated from blocked, braced, and banded dimensional lumber and plywood.

B. Construction:

1. All cabinet walls, access doors, and roof shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.
2. Unit insulation shall have a minimum thermal resistance R-value of 13. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested

in accordance with ASTM D-1929 for a minimum flash ignition temperature of 610°F.

3. Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, reduces heat transfer through the panel and prevents exterior condensation on the panel.
4. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Cabinet leakage shall not exceed 1% of total airflow when tested at 3 times the minimum external static pressure provided in AHRI Standard 210/240. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, at a maximum 8 inches of positive or negative static pressure, to reduce air leakage. Deflection shall be measured at the midpoint of the panel height and width. Continuous sealing shall be included between panels and between access doors and openings to reduce air leakage. Refrigerant piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.
5. Roof of the air tunnel shall be sloped to provide complete drainage. Cabinet shall have rain break overhangs above access doors.
6. Access to filters, dampers, cooling coil, reheat coil, heaters, energy recovery wheel, compressor, water-cooled condenser and electrical and controls components shall be through hinged access doors with quarter turn lockable handles. Full length stainless steel piano hinges shall be included on the doors.
7. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
8. Units with cooling coils shall include double sloped 304 stainless steel drain pans.
9. Unit shall be provided with through the base vertical (left side horizontal) discharge and return air openings. All openings through the unit shall have upturned flanges of at least 1/2 inch around the opening.
10. Unit shall include lifting lugs on the top of the unit.
11. Unit shall include factory installed welded wire mesh screen on the face of the condenser coil.

12. Options to be included in the unit provided for the rare books room:
    a. Interior ceiling, floor, service doors, fan inlet cone, damper rack, and filter rack in the air stream are spray coated with a two-part polyurethane, heat baked coating. The coils, coil casings, condensate drain pans, damper blades and gears, fan wheel, fan motor, energy recovery wheel casing, and compressor cabinet are not coated. Option is intended for use in coastal saltwater conditions under the stress of heat, salt, sand and wind and is applicable to all corrosive environments where a polyurethane coating is acceptable. Coating withstands at least 2,500 hours when tested under ASTM B 117-95 requirements.
    b. Unit base pan shall be provided with 1/2 inch thick foam insulation.
    c. Unit shall include factory installed burglar bars on the supply and return air openings.
    d. Unit shall include factory wired control panel and heat access compartment LED service lights.
    e. Unit shall include factory provided and installed UV lights.

C. Electrical:
1. Unit shall be provided with standard power block for connecting power to the unit.
2. Unit shall have a 5 (10) kAIC SCCR.
3. Options to be included in the unit provided for the Rare Books Room:
    a. Unit shall be provided with factory installed and factory wired, non-fused disconnect switch.
    b. Air-source heat pump shall include an optimized start defrost cycle to prevent frost accumulation on the outdoor coil during heat pump heating operation and to minimized defrost cycle energy usage. If the temperature of the outdoor heat exchanger and/or the suction line is less than a predetermined value, a deferred defrost cycle is initiated wherein the defrost cycle starts after a variable, continuously optimizing, time interval has elapsed. The defrost cycle is terminated when the relative temperatures of the outdoor heat exchanger and/or the suction line indicate that sufficient frost is melted from the heat exchanger to insure adequate time between successive defrost cycles for optimizing the efficiency and reliability of the system, or after a predetermined

time interval has elapsed, whichever condition occurs first. During defrost cycle all compressors shall energize, reversing valves shall de-energize, and auxiliary heat shall energize via the Orion Controls System

c. Unit shall be provided with factory installed and field wired 115V, 20 amp GFI outlet in the unit control panel.

d. Unit shall be provided with phase and brownout protection which shuts down all motors in the unit if the electrical phases are more that 10% out of balance on voltage, the voltage is more that 10% under design voltage, or on phase reversal.

e. Unit shall be provided with manual reset low temperature limit controls that shut off the unit when the discharge temperature reaches a field adjustable setpoint. Supply air temperature sensor shall be factory provided for field installation in the supply air ductwork.

f. Unit shall be provided with blower auxiliary contacts on the low voltage terminal block which close when the supply fans are energized.

g. Unit shall be provided with remote stop/start terminals which require contact closure for unit operation. When these contacts are open the low voltage circuit is broken and the unit will not operate.

D. Supply Fan:

1. Unit shall include direct drive, unhoused, backward curved, plenum supply fan.
2. Blower and motor shall be dynamically balanced.
3. Options:
   a. Motor shall be a high efficiency electrically commutated motor.
   b. Motor shall be standard (inverter rated) efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.

E. Cooling Coil:

1. Evaporator Coil:
   a. Coil shall be designed for use with R-454B refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.
   b. Coil shall be standard (6 row high) capacity.
   c. Coil shall be helium or hydrogen leak tested.

d. Coil shall be furnished with a factory installed thermostatic (electronic) expansion valve.

F. Refrigeration System:

1. Unit shall be factory charged with R-454B refrigerant.
2. Compressor shall be scroll type with thermal overload protection, and carry a 5 year non-prorated warranty, from the date of original equipment shipment from the factory.
3. Compressor shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged compressor access doors shall be fabricated of double wall, rigid polyurethane foam insulated panels to prevent the transmission of noise outside the cabinet.
4. Compressor shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.
5. Each refrigeration circuit shall be equipped with thermostatic (electronic) expansion valve type refrigerant flow control.
6. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides, and factory installed liquid line filter drier.
7. Unit shall include infinite stages of capacity control through variable speed.
8. Options to be provided with the unit serving the Rare Books Room:
    a. Unit shall include an inverter driven, variable speed digital scroll compressor that shall be capable of modulating refrigerant capacity.
    b. Unit shall include factory provided and installed compressor sound jackets on all compressors.
    c. Refrigeration circuit shall be provided with hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a dehumidification control signal terminal which allow the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space.

d. Unit shall be configured as a cold climate air-source heat pump. Refrigeration circuit shall each be equipped with a factory installed liquid line filter drier with check valve, reversing valve, accumulator, and electronic expansion valves on both the indoor and outdoor coils. Reversing valve shall energize during the heat pump cooling mode of operation.

e. Refrigeration circuit shall be equipped with a liquid line sight glass.

f. Refrigeration circuit shall be equipped with suction and discharge compressor isolation valves.

g. Each capacity stage shall be equipped with a 5 minute off, delay timer to prevent compressor short cycling.

h. Unit shall be provided with an adjustable compressor lockout.

i. Unit shall be provided with a power factor correction capacitor on the compressor. The maximum correction factor is 0.9.

j. Refrigeration circuit shall be equipped with flooded condenser low ambient head pressure control to allow operation down to 0°F. Option includes adjustable on/off condenser fan cycling and an adjustable compressor lockout.

k. Refrigeration circuit shall be provided with an adjustable temperature sensor freeze stat which shuts down the cooling circuits when the evaporator coil tubing falls below the setpoint.

G. Condenser:

1. Air-Cooled Condenser:

a. Condenser fan shall be vertical discharge, axial flow, direct drive fan.

b. Coil shall be designed for use with R-410A refrigerant.

c. Heat pump outdoor coil shall be constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.

d. Coil shall be designed for a minimum of 10°F of refrigerant sub-cooling.

e. Options to be provided: Condenser fan shall be high efficiency electrically commutated motor driven with multiple speeds which are controlled with a fan cycle switch based on head pressure and allow matching condenser airflow with cooling capacity steps.

H. Electric Heating:
    1. Unit shall include an include electric heater consisting of electric heating coils, fuses, and a high temperature limit switch, with capacities as shown on the plans.
    2. Unit shall include SCR Control
    3. Electric heating coils shall be located in the reheat position downstream of the supply fans.
    4. Options to be provided for the Rare Books Room Unit: Electric heater shall have full modulation capacity controlled by an SCR (Silicon Controlled Rectifier). A 0-10 VDC heating control signal shall be field provided to control the amount of heating.

I. Filters:
    1. Options to be included:
        a. Unit shall include 4 inch thick, pleated panel filters with an ASHRAE MERV rating of 13, upstream of the cooling coil. Unit shall also include 2 inch thick, pleated panel pre filters with an ASHRAE MERV rating of 8, upstream of the 4 inch standard filters.
        b. Unit shall include a clogged filter switch.
        c. Unit shall include a Magnehelic gauge mounted in the controls compartment.

J. Outside Air/Economizer: None desired

K. Controls:
    1. Factory Installed and Factory Provided Controller:
        a. Unit controller shall be capable of controlling all features and options of the unit. Controller shall be factory installed in the unit controls compartment and factory tested.
        b. Controller shall be capable of standalone operation with unit configuration, set point adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling available without dependence on a building management system.
        c. Controller shall have an onboard clock and calendar functions that allow for occupancy scheduling.
        d. Controller shall include non-volatile memory to retain all programmed values, without the use of an external battery, in the event of a power failure.

e. Constant Volume Controller:

1) Unit shall modulate cooling with constant airflow to meet space temperature cooling loads.

2) With modulating hot gas reheat, unit shall modulate cooling and hot gas reheat as efficiently as possible, to meet space humidity loads and prevent supply air temperature swings and overcooling of the space.

3) Unit shall modulate heating with constant airflow to meet space temperature heating loads. With staged heating, capacity shall modulate based on space temperature. With modulating heating, capacity shall modulate based on supply air temperature.

4) Controls shall consist of a discharge air temperature controller downstream of the cooling coil, and upstream of the SCR Electric Reheat coil. The digital scroll shall modulate to provide precise discharge air control to provide dehumidification for the rare books room. The room thermostat shall control the SCR reheat coil, independent of the cooling, for both temperature and humidity control.

f. Options to be provided: Unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling shall be accomplished with connection to interface module with LCD screen and input keypad, interface module with touch screen, or with connection to PC with free configuration software. Controller shall be capable of connection with other factory installed and factory provided unit controllers with individual unit configuration, setpoint adjustment, sensor status viewing, and occupancy scheduling available from a single unit. Connection between unit controllers shall be with a modular cable. Controller shall be capable of communicating and integrating with BACnet network via the Orion Controls System.

2. Field Installed DDC Controls INTERFACE: Units shall interface via color graphics with the existing Johnson Controls Metasys system. Remote setpoint adjust from the JCI system shall be included. Also include annunciation of all alarms and maintenance messages into the JCI system. All gateway points in the local controller shall be mapped into the JCI system via BACnet MS/TP.

a. Isolation relays shall be factory installed.

2.3 CURBS

A. Curbs shall to be fully gasketed between the curb top and unit bottom with the curb providing full perimeter support, cross structure support and air seal for the unit. Curb gasket shall be furnished within the control compartment of the rooftop unit to be mounted on the curb immediately before mounting of the rooftop unit.

B. Knockdown curbs (with duct support rails) shall be factory furnished for field assembly.

C. Solid bottom curb shall be factory assembled and fully lined with 1 inch fiberglass insulation and include a wood nailer strip. (Curb shall be adjustable up to 3/4 inch per foot to allow for sloped roof applications.)

PART 3 - EXECUTION

3.1 INSTALLATION, OPERATION, AND MAINTENANCE

A. Installation, Operation and Maintenance manual shall be supplied with the unit.

B. Installing contractor shall install unit, including field installed components, in accordance with Installation, Operation and Maintenance manual instructions.

C. Start up and maintenance requirements shall be complied with to ensure safe and correct operation of the unit.

END OF SECTION 237100

SECTION 238000 - CONTRACT FOR TESTING, ADJUSTING AND BALANCING MECHANICAL SYSTEMS

(Not in Contract - Information Only)

PART 1 - GENERAL

Furnish all labor, materials, transportation, tools, appliances. Perform all operations in connection with the testing, balancing and adjustment of systems to produce proper environment conditions in the building. Achieve proper flows of air and water, correct setting of regulating devices and other end results as more fully described hereinafter.

1.1 QUALIFICATIONS

A. The Testing, Adjusting and Balancing (TAB) of the air conditioning systems will be performed by a Technical Firm whose operations are limited only to the field of professional TAB. The TAB work shall be done under the direct supervision of a qualified engineer employed by the TAB firm.

1.2 DOCUMENTS

A. The selected TAB firm will be furnished a set of construction documents for the project, including plans and specifications. These documents constitute a part of the contract for the construction of the project. Where the term "Contractor" occurs in this specification, reference is made to the Contractor for the construction of the project.

1.3 SERVICES TO BE PERFORMED

A. Preliminary Report and Deficiency List: Upon notification from the Engineer that the system is ready for TAB, inspect the installation of heating and cooling piping systems, sheet metal work, temperature controls and other component parts of the heating, air conditioning, and ventilating systems. The inspection of the work shall cover that part relating to proper arrangement and adequate provisions for the testing and balancing. Prepare and submit Deficiency List to Engineer.

B. Final Report: Upon Contractor's written response to the Deficiency List, check, adjust, and balance systemic components to obtain optimum conditions in each conditioned space in the building. Prepare and submit complete reports on the balance and operations of the system. This report shall indicate the recommended RPM and

computed fan brake horsepower requirements for operating the VAV systems as balanced.

C. Final Inspection: Make a total of three inspections within 90 days after completion of the TAB contract to insure that satisfactory conditions are being maintained throughout and to satisfy any unusual conditions. Final inspection with Engineer and Texas Tech Staff with "punch list" and space check.

D. Offseason Report: Make inspections in the building during the opposite season from that in which the initial adjustments were made and at those times make any necessary modifications to the initial adjustments required to produce optimum operation of the systemic components and produce the proper conditions in each conditioned space. Report to Engineer.

1.4 CONDITIONS

A. The TAB agency shall be responsible for inspecting, adjusting, balancing and logging the data on the performance of fans, all dampers in the duct systems, all air distribution devices, and the flows of steam or water through all coils.

B. During the balancing the temperature regulation will be adjusted for proper relationship between controlling instruments and calibrated. The correctness of the final setting shall be proved by taking hourly readings for a period of four successive eight-hour days, in each separately controlled zone. The total variation shall not exceed two degrees from the preset median temperature during the entire survey period.

C. In all fan systems, the air quantities shown on the plans may be varied as required to secure a maximum temperature variation of two degrees within each separately controlled zone, but the total air quantity indicated for each zone must be obtained.

D. The various water circulating systems shall be filled, purged of air and put into operation before hydronic balancing.

E. The flow of water in the various systems shall be adjusted, using the flow meters and system balancing valves indicated at the various points in the systems.

F. The flow of water through all water coils shall be adjusted, using the flow meters and system balancing valves indicated at the various points in the systems.

PART 2 - DATA REQUIRED

2.1 GENERAL

A. Before final acceptance is made, the balancing agency shall furnish the following data. The data shall be neatly entered on appropriate forms together with any typed supplements required to completely document all results. Written explanations of any abnormal conditions are required. Submit 4 copies of the report.

1. Air System Data:
    a. Equipment (fan or factory fabricated station unit):
        1) Installation Data
        2) Manufacturer and Model
        3) Size
        4) Arrangement, Discharge and Class
        5) Motor H.P., Voltage, Phase, Cycles, and Full Load Amps
        6) Motor sheave diameter, fan sheave diameter, number and size of belts.
        7) Location and local identification data.
    b. Design Data: Data listed in schedules on drawings and specification.
        1) Fan (Air Unit) Recorded (Test) Data
        2) C.F.M. and operating static pressure set point.
        3) Operating G.P.M. (From pump curves if metering is not provided
        4) No-Load Amps and Full-Load Amps (Where Possible)
        5) Full-Flow Amps (Where scroll dampers are installed)
        6) Minimum-Flow Amps. (Where scroll dampers are installed)
2. Air Heating and Cooling Equipment:
    a. Design Data
        1) Load (B.t.u.h. or MBH)
        2) G.P.M. or steam pressure
        3) Entering and leaving temperature
        4) Entering and leaving air conditions (D.B. and W.B.) each zone
        5) C.F.M.
        6) Water Pressure Drop
    b. Recorded Data
        1) Type of equipment and identification (location or number designation)

2) Entering and leaving air conditions (D.B. and W.B.) each zone
3) Entering and leaving water temperature
4) G.P.M. or steam pressure
5) Temperature rise or drop

3. Duct Systems:
   a. Duct Quantities (Maximum and Minimum) - Mains, Submains,
      1) Branches, outdoor (Outside) Air, Total Air, and Exhaust.
      2) Duct size(s)
      3) Number of Pitot tube (Pressure) Measurements
      4) Sum of Velocity Measurements (Note: Do Not Add Pressure Measurement)
      5) Average Velocity
      6) Recorded (Test) C.F.M.
      7) Design C.F.M.
      8) Static pressure at Static Pressure Sensors in Cold Duct.
      9) Static pressure at Static Pressure Sensors in Hot Duct.
   b. Individual Air Terminals
      1) Terminal Identification (Supply or Exhaust, Location and Number designation)
      2) Type, Size, Manufacturer & Catalog Identification
      3) Applicable Factor for application, Velocity, Area, etc., and Designated Area
      4) Design and Recorded Velocities - F.P.M.
      5) Design and Recorded Quantities - C.F.M.
      6) Deflector vane or Diffusion Cone Settings
4. Temperature Control Data:
   a. Design Data
      1) Inside design temperature (DB & WB)
      2) Inside Relative Humidity
      3) Outside Design Temperatures (DB & WB)
   b. Recorded Data
      1) Hourly temperature readings (DB & WB) in each room

2) Corresponding Outdoor Temperature Readings (DB & WB)

3) Relative Humidity

PART 3 – FINAL INSPECTION

3.1 RECHECK

A. At the time of final inspection, the TAB agency shall recheck, in the presence of the Owner's Representative, specific and random selections of data (water and air quantities and air motion) recorded in the Certified Report. Points and areas for recheck shall be selected by the Owner's Representative. Measurement and test procedures shall be the same as approved for work forming basis of Certified Report. Selections for recheck (specific plus random) in general, will not exceed 25 percent of the total number tabulated in the report, except that special air systems may require a complete recheck for safety reasons.

B. If random test elicits a measured flow deviation of ten percent or more from that recorded in the Certified Report listings, by ten percent or more of the selected recheck stations, the report shall be automatically rejected. In the event the report is rejected, all systems shall be readjusted and tested, new data recorded, new Certified Reports submitted, and new inspection tests made, all at no additional cost to the Owner.

3.2 ACCEPTANCE

A. Following final acceptance of Certified Reports by the Owner, the settings of all valves, splitters, dampers, controllers and other adjustment devices shall be permanently marked so that adjustment can be restored if disturbed at any time.

END OF SECTION 238000

SECTION 250000 – TEMPERATURE REGULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes control equipment for HVAC systems and components.

1.3 DEFINITIONS

A. FMS: Facility Management System.

B. ASC: Application Specific Controller.

C. BMS: Building Management System.

D. DDC: Direct Digital Control

E. GUI: Graphical User Interface

F. HVAC: Heating, Ventilation, and Air Conditioning

G. LAN: Local Area Network.

H. PID: Proportional, Integral, Derivative

I. NAE: Network Automation Engineer

J. UNT: Unitary Controller

K. VAV: Variable Air Volume

L. UDP: User Datagram Protocol

1.4 SCOPE

A. Furnish and install a BMS to control the equipment as shown on the drawings and described herein. System shall connect to and be compatible with the existing Johnson Controls Metasys system installed at TTUHSC.

B. Provide and install the 120V/24V transformers for adequate power to all the new electronic controls serving VAV boxes. All 120V power requirements to control panels shall be provided by division 26 contractor. Refer to the drawings for line voltage connections. All boxes shall be connected to line voltage power.

C. Furnish all labor, materials, equipment, and service necessary for a complete and operating temperature control system, utilizing a high-speed peer to peer network of Direct Digital Controls as shown on the drawings and as described herein.

D. Drawings are diagrammatic only. Equipment and labor not specifically referred to herein or on the plans, that are required to meet the functional intent, shall be provided without additional cost to the Owner.

E. Complete temperature control system to be DDC with electronic sensors and electric actuation of valves and dampers and electronic actuation of terminal equipment valves and actuators as specified herein.

F. All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work and in the regular employment of the temperature control system manufacturer. The local installing office shall be a manufactured owned branch and shall have a minimum of twenty years of installation experience. Supervision, calibration and checkout of the system shall be by the employees of the local temperature control contracting office. Supplier shall have an in-place support facility within 150 miles of the site with technical staff, spare parts inventory and all necessary test and diagnostic equipment.

G. All installation labor (i.e., wiring, conduit, tubing, etc.) and installation material for the installation of the control system, including all power requirements, shall be provided by the temperature control subcontractor.

H. All programs that reside in the DDC System Controllers shall be accessible from the user interface though the TTUHSC operator workstation, such that program parameters, pid loop adjustments, and changes can be made live without disruption to the control process or equipment being controlled. Systems that require the above changes to be made at the building, or interrupt equipment operation, are not acceptable.

1.5 FMS DESCRIPTION

A. The FMS shall be a complete system designed for use on Intranets and the Internet. This functionality shall extend into the equipment rooms. Contractor shall be responsible for coordination with the owner’s IT staff to ensure that the FMS will perform in the owner’s environment without disruption to any of the other activities taking place on that LAN.

B. All points of user interface shall be on standard PCs that do not require the purchase of any special software from the FMS manufacturer for use as a building operations

terminal. The primary point of interface on these PCs will be a standard Web Browser such as Internet Explorer.

C. The FMS work shall consist of all labor, materials, tools, equipment, software, software licenses, wiring, tubing, installation, engineering, calibration, documentation, submittals, testing, verification, training services, permits and licenses, management, warranties, services and items as Specified in these Division documents which are required for the complete, fully functional and commissioned FMS.

1.6 QUALITY ASSURANCE

A. Bids by wholesalers, franchised, and non-franchised contractors shall not be acceptable.

B. The system manufacturer shall, as a minimum, manufacture and supply the Application Specific Controllers, Supervisory Controllers, Graphical User Interface, damper actuators, and valve actuator assembly.

C. All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work and in the direct employment of the temperature control system manufacturer.

D. The Building Management System contractor shall have a full-service facility that is staffed with engineers in Johnson Controls systems and technicians fully capable of providing instructions and routine emergency maintenance service on all Johnson Controls system components.

E. Mechanical equipment manufacturers desiring to provide DDC type controls as factory mounted equipment shall not be acceptable.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

G. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."

H. Comply with National Electric Code.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to unit manufacturer.

1.8 COORDINATION

A. Coordinate location of thermostats and other exposed control sensors with plans and room details before installation.

B. Coordinate supply of conditioned electrical circuits for control units and panels. Electrical circuits provided by division 26 contractor.

1.9 SYSTEM INSTALLATION GUIDELINES

A. All exposed temperature control and interlock wiring shall be installed in conduit, unless otherwise noted on the plans. Power or interlock wiring shall be run in separate conduit from sensor and communications wiring.

B. All non-plenum rated cable will be run in conduit from termination-to-termination points.

C. Plenum rated cabling run in the return plenum above dropped ceilings does not need to be run in conduit but shall be installed and supported as close as possible to the structural members. Main cable bundles shall, in general, run above Corridor ceilings, with individual cables extending above ceiling to the terminal units. Cable shall not lay on the ceiling grid, lights, ductwork etc. It will be run at right angles, parallel and perpendicular to the building lines with run outs into rooms being perpendicular to the main cable bundles.

D. All wiring within Mechanical Rooms or Air Handling Rooms shall be run in conduit. Wiring extending from these rooms shall be installed in conduit that extends a minimum of 12” beyond the mechanical room wall. Remote satellite boxes used for housing control transformers shall be located above accessible ceilings of Corridors within 10 feet of mechanical rooms. Control transformers shall not be installed above ceilings of limited access areas such as offices, conference rooms, office suites, etc. or above non-accessible ceilings.

E. All plenum rated cabling run in standard drywall construction will be run inside the wall in new or existing conduit which extends six inches above the top plate of the wall and exiting the wall through standard wall boxes.

F. On wall constructed of solid concrete, cinder block or plaster, cables will be run in concealed conduit, surface wire mold or other approved raceway.

G. No ceiling tiles will be removed, or holes punched out to accommodate cable penetration into a room.

H. Cabling shall be bundled neatly and well secured using nylon zip straps. It shall not be wrapped around piping or conduit. Support cabling at walls, to sub-ceiling or structural steel with wall locks or clamps. Cabling shall not be installed with excessive slack.

I. Cables requiring crimp-on connectors must have those connectors attached with an appropriate and recommended specialized crimping tool.

J. Identify each item, mounted on the face of a control panel, with a label (1/4" letters minimum).

K. Thermostats or sensors mounted on outside walls shall be mounted on an insulated mounting base (or equal).

L. All sensor elements in water lines shall be installed in separable wells, packed with heat conductive compound.

1.10 SYSTEM PERFORMANCE

A. Performance Standards. The system shall conform to the following:

1. Graphic Display. The system shall display a graphic with 20 dynamic points with all current data within 20 seconds.
2. Graphic Refresh. The system shall update a graphic with 20 dynamic points with all current data within 20 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 less than 5 seconds. Analog objects should start to adjust within 5 seconds.
4. Object Scan. All changes of state and change of analog values will be transmitted over the high-speed network such that any data used or displayed at a controller or workstation will be updated within 60 seconds.
5. Alarm Response Time. The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall be 20 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. Performance. Digital controllers shall be able to execute DDC PID control loops at a selectable frequency of at least once per second. The controller shall scan and update the process value and output generated by this calculation at this same frequency.

8. Multiple Alarm Annunciation. All workstations on the network must receive alarms within 5 seconds of each other.
9. Reporting Accuracy. The system shall report all values with an end-to-end accuracy as listed or better than those listed below:

Measure Variable	Reported Accuracy
Space Temperature	±1ºF
Ducted Air	±1ºF
Outside Air	±2ºF
Dew point	±3ºF
Water Temperature	±1ºF
Relative Humidity	±5% RH
Water Flow	±5% of full scale
Airflow (terminal)	±10% of reading
Airflow (measuring stations)	±5% of full scale
Air Pressure (ducts)	±0.1 "W.G.
Air Pressure (space)	±0.01 "W.G.
Water Pressure	±2% of full scale (absolute or differential)
Electrical	5% of reading (A, V, W, Power factor)
Carbon Dioxide (CO2)	±5% of reading

10. Stability of Control. Control loops shall maintain measured variable at set point within the tolerances listed below:

Controlled Medium	Control Range of Variable	Accuracy
Air Pressure		±0.2" w.g.0-6" w.g.
		±0.01" w.g. 0.1 to 0.1" w.g.
Airflow		± 5% of full scale
Temperature		±1.0ºF
Humidity		±5% RH
Fluid Pressure		±1.5 psi 1-150 psi
		±1.0" w.g.
		0-50"w.g. differential

1.11 WORK BY OTHERS

A. Smoke detectors shall be furnished and installed by the electrical contractor. The temperature controls subcontractor shall be responsible for interlock wiring between the smoke detectors and the air handling unit safety circuits.

B. Motor starters shall be furnished under Division 23 and installed by the electrical contractor. The temperature controls subcontractor shall be responsible for all wiring necessary involving the starter to perform the sequence of operation specified.

C. All temperature wells, taps, dampers and actuated control valves shall be installed by the mechanical contractor.

1.12 QUALITY ASSURANCE

A. Five (5) copies of shop drawings of the entire control system shall be submitted and shall consist of a complete list of equipment and materials, including manufacturer's catalog data sheets and installation instructions. Shop drawings shall also contain complete wiring and schematic diagrams, software descriptions, calculations, and any other details required to demonstrate that the system has been coordinated and will properly function as a system. Terminal identification for all control wiring shall be shown on the shop drawings.

B. A complete written Sequence of Operation as well as a hard copy graphical depiction of the application control programs shall also be included with the submittal package. Device identification as shown on the control schematics and wiring diagrams shall be referenced in the written Sequence of Operation.

C. System Architecture: Provide a schematic diagram of the Local Area Network and a controls network architecture diagram indicating supervisory controllers and Graphical User Interface(s). This should be accompanied by explicit information regarding configuration of Routers, Bridges and Repeaters. Each schematic shall have all control points labeled. The schematic shall graphically show all control elements. The point name format shall be approved by the Engineer before any drawing or programming proceeds.

1.13 WARRANTY

A. The temperature control system contractor shall provide a one (1) year warranty that will commence from the Date of Substantial Completion.

B. The contractor shall respond during normal business hours to the job site within a 24-hour period for any emergency relating to the control system during the warranty period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Johnson Controls; no exceptions

2.2 GENERAL

A. All materials and equipment used shall be standard components, of regular manufacture for this application. All systems and components shall have been thoroughly tested and proven in actual use.

B. All products used in this project shall be new, currently under manufacture, and shall be applied in similar installations for a minimum of 2 years. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner's Representative in writing. Spare parts shall be available for at least 5 years after completion of this contract.

2.3 MATERIALS

A. Wiring and Conduit:

1. All wire shall be copper and meet the minimum wire size and insulation class listed below:

Wire Class	Wire Size	Isolation Class
Power	12 Gauge	600 Volt
Class One	14 Gauge Std.	600 Volt
Class Two	18 Gauge Std.	300 Volt
Class Three	18 Gauge Std.	300 volt
Communications	Per Mfr. Recommendations	

2. Power and Class One wiring may be run in the same conduit. Class Two and Three wiring and communications wiring may be run in the same conduit.

3. Where different wiring classes terminate within the same enclosure, maintain clearances and install barriers per the National Electric Code.

4. Where wiring is required to be installed in conduit, EMT shall be used. Conduit shall be minimum ½ inch galvanized EMT. Watertight compression fittings shall be

used. Provide conduit seal off fitting where exterior conduits enter the building or between areas of high temperature/moisture differential.

5. Flexible metallic conduit (max. 3 feet) shall be used for connections to controllers, and sensors mounted on vibration producing equipment. Liquid-tight flexible conduit shall be use in exterior locations and interior locations subject to moisture.
6. Junction boxes shall be provided at all cable splices, equipment terminations, and transitions from EMT to flexible conduit. Interior dry location J-boxes shall be galvanized pressed steel, nominal four-inch square with blank cover. Exterior and damp location JH-boxes shall be cast alloy FS boxes with threaded hubs and gasketed covers.

B. Damper and Valve Actuators:

1. Control air damper actuators shall be electric, low voltage (24 VAC) utilizing a 4-20 mA modulating control signal as required by the sequence of operation. Each actuator shall incorporate a spring return to position the dampers to their normal positions upon a loss of the 24 VAC control power. Control air damper actuators shall be properly sized to provide sufficient torque to their respective dampers throughout the actuator's operating range. All control air damper actuators shall be mounted outside of the air stream. Provide low leakage controls dampers to prevent air leakage for better pressure control of the zone. Provide fast acting actuators for better smoke purge reaction time.
2. Valve actuators for heating water and chilled water systems shall be electric. Operators shall be sized to operate their appropriate valves with sufficient reserve power to provide smooth modulating action or two position action as specified.

C. Control Panels: All application specific direct digital controllers, not specifically designed for direct mounting on the equipment served, shall be installed in NEMA 1 enclosures. Enclosures shall be of suitable size to accommodate all power supplies, relays and accessories required for the application. Each enclosure shall include a perforated subpanel for direct mounting on the enclosure devices.

D. Temperature Sensors:

1. Duct/Wall Sensors: As required by the sequence of operation, provide either 1,000 OHM Balco or 10K OHM Thermistor type sensors. Where the element is used for sensing mixed air or coil discharge temperatures and/or the duct cross-sectional

area is in excess of 14 square feet, the element shall be of the averaging type. Where temperature elements are used for sensing liquid temperatures, they shall be furnished with separable stainless-steel wells. Cold Deck and Hot Duct temperature sensor product shall be a Johnson Controls TE-6311M-1. Mixed air temperature sensor product shall be a Johnson Controls TE-6316M-1. Discharge air temperature sensors for zone sensors shall be Johnson Controls NS-BTN7001-0.

2. Space Temp/Humidity Sensors: Space temperature/humidity sensors shall be Resistance temperature devices (RTD), or thermistor equipped with set point adjustment, override switch, and communication port. Humidity accuracy shall be 3%. LCD shall be provided for the temperature and the humidity. Product shall be a Johnson Controls NS-BHB7002-0.
3. Binary Temperature Devices:
    a. Low-voltage space thermostat shall be 24 V, bimetal-operated, snap action type, with either adjustable or fixed anticipation heater, concealed setpoint adjustment, 55°F to 85°F setpoint range, 2°F maximum differential, and vented ABS plastic cover.
    b. Line-voltage space thermostat shall be bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch type, or equivalent solid-state type, with heat anticipator, UL listed for electrical rating, concealed setpoint.
    c. Low-limit thermostats. Low-limit thermostats shall be vapor pressure type with an element 20 ft minimum length. Element shall respond to the lowest temperature sensed by any 1 ft section. The low-limit thermostat shall be manual reset only. Product shall be a Johnson Controls A70HA-1C. This shall be installed on the hot deck and cold deck coils.

E. Analog Current Sensors: As required by the sequence of operation, provide split-core, sensors for indication of equipment amperage. Span shall be adjustable for improved resolution. Current sensors shall incorporate trip indication LED’s and shall be sized for proper operation with equipment they serve. Current sensors and installation to be provided under work of this section.

F. Pressure Sensors:

1. Differential pressure type switches shall be UL Listed, SPDT snap acting, pilot duty rated, NEMA 4 enclosure, with scale range and differential suitable for intended applications, or as shown.
2. Differential pressure sensors used for sensing pressure in the ductwork shall be Johnson Controls DPT2641-005D-1 with a FTG18A-600R.
3. As required by the sequence of operation, provide a differential pressure switch across each air handling unit filter section for unit filter alarm indication. Product shall be a Johnson Controls P32AC-2C with a FTG18A-600R.
4. Differential pressure sensors used for high static pressure in duct work shall be a Johnson Control AFS-460 with a FTG18A-600R.

G. Duct Temperature/Humidity Sensor: The temperature and humidity combination sensor shall be used in calculated enthalpy for the economizer function. Product shall have 3% accuracy with a 1k Ohm nickel temperature sensor. Product shall be Johnson Control HE-67N3-0N00P. This device will be installed in the return air and outside air duct work.

H. Damper Actuators: The damper actuators shall be incremental, non-spring return, with a torque of 35 lb*in, and a built-in pressure differential transmitter. The damper actuators shall be a Johnson Controls M9104-AGS-2N.

2.4 DDC EQUIPMENT

A. Workstation Client Hardware Stations: The system shall be capable of supporting clients using a standard Web browser such as Internet Explorer™ operating on any standard computer that supports the current version of Internet Explorer™.

B. Web Browser Clients:

1. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.
2. The Web browser client shall support at a minimum, the following functions:
    a. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using

Java authentication and encryption techniques to prevent unauthorized access shall be implemented.

b. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.

c. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.

d. Storage of the graphical screens shall be in the Building Control Units (BC), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.

e. Real-time values displayed on a Web page shall update automatically without requiring a manual “refresh” of the Web page.

f. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:

    1) Modify common application objects, such as schedules, calendars, and set points in a graphical manner.

    2) Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.

    3) Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.

    4) Commands to start and stop binary objects shall be done by right clicking the selected object and selecting the appropriate command from the pop-up menu.

    5) View logs and charts.

    6) View and acknowledge alarms.

    7) The system shall provide the capability to specify a user’s (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.

8) Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

C. Control Units General:

1. Provide an adequate number of control units to achieve monitoring and control of all data points specified and necessary to satisfy the sequence of operation for all mechanical systems shown on the plans. Provide a minimum of one separate controller for each AHU or other HVAC system. Multiple DDC controllers may control one system provided that all points associated with individual control loops are assigned to the same DDC controller. Points used for control loop reset such as outside air or space temperature are exempt from this requirement. Each of the following panel types shall meet the following requirements.
2. Controllers shall be suitable for the anticipated ambient conditions.
3. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at -40°F to 140°F and 5 to 95% RH, non-condensing.
4. Controllers used in conditioned ambient space shall be mounted in dust-proof enclosures and shall be rated for operation at 32°F to 122°F and 5 to 95% RH, non-condensing.
5. Serviceability: Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
6. Memory: The Control Units shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.
7. Diagnostics: The Building Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall assume a predetermined failure mode and generate an alarm notification.
8. Immunity to power and noise: Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 ft.

9. Automatic staggered restart of field equipment after restoration of power and short cycle protection.

D. Supervisory Network Engine (SNE):

1. The Supervisory Network Engine (SNE) shall provide the interface between the LAN or WAN and the field control devices and provide global supervisory control functions over the control devices connected to the UNC. It shall be capable of executing application control programs to provide:
   a. Calendar functions
   b. Scheduling
   c. Trending
   d. Alarm monitoring and routing
   e. Time synchronization by means of an Atomic Clock Internet site including automatic synchronization
   f. Integration data and BACnet controller data
2. The Supervisory Network Engine (SNE) must provide the following hardware features as a minimum:
   a. One Ethernet Port – 10/100 Mbps
   b. One RS-232 port
   c. Battery Backup
   d. Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity)
3. SNE shall provide the capability for multiple user access to the system and support for relational database access (ODBC, SQL or IBM). A database resident on the NAE shall be ODBC compliant database or must be capable of supporting an ODBC data access mechanism to read and write data stored within it.
4. SNE shall provide the capability to support standard Web browser access via the Intranet/Internet. It shall support a minimum of 4 simultaneous users.
5. Event Alarm Notification and Actions:
   a. The SNE shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.

b. The SNE shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up telephone connection, or wide-area network.

c. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to:
   1) To alarm
   2) Return to normal
   3) To fault

d. Provide for the creation of a minimum of eight of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.

e. Provide timed (schedule) routing of alarms by class, object, group, or node.

f. Provide alarm generation from binary object “runtime” and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.

g. Control equipment and network failures shall be treated as alarms and annunciated.

h. Alarms shall be annunciated in any of the following manners as defined by the user.

i. Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:
   1) Day of week
   2) Time of day
   3) Recipient

j. Pagers via paging services that initiate a page on receipt of email message.

k. The following shall be recorded by the SNE for each alarm (at a minimum):
   1) Time and date
   2) Location (building, floor, zone, office number, etc.)
   3) Equipment (air handler #, accessway, etc.)
   4) Acknowledge time, date, and user who issued acknowledgement.
   5) Number of occurrences since last acknowledgement.

l. Alarm actions may be initiated by user defined programmable objects created for that purpose.

m. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.

n. Provide a “query” feature to allow review of specific alarms by user defined parameters.

o. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.

p. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.

E. General Purpose Application Controllers (CGM04060 & CGM09090):

1. Standalone DDC panels shall be microprocessor-based, multi-tasking, multi-user, real-time digital control processors. Each standalone DDC panel shall consist of modular hardware with plug-in enclosed processors, communication controllers, power supplies, and input/output modules. A sufficient number of controllers shall be supplied to fully meet the requirements of this Specification and the attached point list.

2. Hardware Overrides – As indicated in the point schedule, the operator shall have the ability to manually override automatic or centrally execute commands.

3. Hardware Override Monitoring – DDC panels shall monitor the status or position of all overrides and include this information in logs and summaries to inform the operator that automatic control has been inhibited. DDC panels shall also collect override activity information for daily and monthly reports.

4. Sensor Support

a. The controller shall communicate over the Sensor-Actuator Bus (SA Bus) with a Network sensor.

b. The Network Sensor shall support an LCD display room sensor.

F. VAV Box Controller

1. The VAV Box Controller (hereafter referred to as CVM) shall provide both standalone and networked DDC of pressure independent, VAV terminal units.

2. The CVM controller shall be a fully programmable, digital controller that communicates via BACnet MS/TP protocol.

a. The CVM shall support BACnet Standard ANSI/ASHRAE 135.

1) The CVM shall be BTL listed/certified.

2) The CVM shall be tested and certified as a BACnet Advanced Application Controller (B-AAC).
3) A BACnet Protocol Implementation Conformance Statement shall be provided for the CVM.
4) The Conformance Statement shall be submitted 10 days prior to bidding.

3. The CVM shall employ finite state programming to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.
4. The CVM shall include an integral real-time clock and support time-based tasks which enables these equipment controllers to monitor and control:
   a. Schedules
   b. Calendars
   c. Alarms
   d. Trends
5. The CVM can continue time-based monitoring when offline for extended periods of time from a network.
6. The CVM shall include an integral differential pressure transducer and damper actuator. An additional configuration option shall be available that also includes an integral potentiometer for actual damper position feedback. All components shall be connected and mounted as a single assembly, removable as one piece.
7. The integral damper actuator shall be a fast response stepper motor capable of stroking 90 degrees in 60 seconds for quick damper positioning to speed commissioning and troubleshooting tasks.
8. The CVM shall have the ability to automatically calibrate the flow sensor to eliminate pressure transducer offset error due to ambient temperature / humidity effects.
9. The CVM can operate as a stand-alone controller in applications that do not require a networked supervisory device or for network applications where it is preferred to have the scheduling, alarming, and/or trending performed locally in the equipment controllers.

10. Sensor Support:
    a. The controller shall communicate over the Sensor-Actuator Bus (SA Bus) with a Network sensor.
    b. The Network Sensor shall support an LCD display room sensor.

G. Network Sensors:
1. The Network Sensors shall have the ability to monitor the following variables as required by the systems sequence of operation:
    a. Zone temperature
    b. Zone humidity
    c. Zone setpoint
    d. Discharge air temperature
    e. Zone CO2
2. The Network Sensor shall transmit the information back to the controller on the SA Bus using BACnet standard protocol SSPC-135.
3. The Network Zone Temperature Sensor shall include the following items:
    a. A backlit LCD to indicate the temperature, humidity and setpoint.
    b. An LED to indicate the status of the override feature.
    c. A button to toggle the temperature display between Fahrenheit and Celsius
    d. A button to initiate a times override command

PART 3 - EXECUTION

3.1 INSTALLATION AND WORKSMANSHIP

A. Install equipment, piping and wiring raceway parallel to the 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 Chapter 1, Article 100, Part A of the National Electric Code (NEC).

D. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.

E. All equipment, installation and wiring shall comply with acceptable industry specifications and standards for performance, reliability and compatibility and be executed in strict adherence to local codes and standard practices.

3.2 ELECTRICAL INTERLOCKS

A. All electrical interlocks shall be provided as specified. All electrical interlocks shall be made by means of motor starters or shall be accomplished by separate relays. No motor power lead shall be utilized in an interlock circuit. All interlocked starters with disconnect switches shall be provided with auxiliary contacts on the disconnect switch so that interlocking circuits are interrupted when the disconnect switch is in the off position.

3.3 OWNERSHIP OF PROPRIETARY MATERIAL

A. The owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to owner as defined by the manufacturer's license agreement but shall protect manufacturer's rights to disclosure of trade secrets contained within such software. All project developed software and documentation shall become the property of the owner. These include, but are not limited to project graphic images, record drawings, project database, project specific application programming code, and all other associated documentation.

3.4 TRAINING

A. Provide a minimum of 8 hours of on-site training throughout the contract period for personnel designated by the Owner. Train the designated staff of Owners Representative and Owner to enable them to:

1. Proficiently operate the system.
2. Understand control system architecture and configuration.
3. Understand DDC system components.
4. Understand system operation, including DDC system control and optimizing routines (algorithms).
5. Operate the workstation and peripherals.
6. Log on and off the system.
7. Access graphics, point reports, and logs.
8. Adjust and change system set points, time schedules, and holiday schedules.
9. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals.
10. Understand system drawings, and Operation and Maintenance manual.
11. Understand the job layout and location of control components.

12. Access data from DDC controller.
13. Operate portable operator's terminals.

PART 4 - SEQUENCE OF OPERATIONS

4.1 DUAL DUCT VAV TERMINAL UNIT - NOTE THAT ALL EXISTING DOUBLE DUCT VAV TERMINALS SHALL BE MODIFIED BY CHANGING THE ACTUATORS AND PNEUMATIC BOX CONTROLLERS WITH A DDC BOX CONTROLLER COMPATIBLE WITH JOHNSON CONTROLS METASYS. WHERE BOXES ARE NEW, PROVIDE THE SPECIFIED DDC BOX CONTROLLERS DUAL DUCT UNITS, MOUNTED IN THE FACTORY OR IN THE FIELD. ALL BOXES SHALL BE OUTFITTED WITH TEMPERATURE SENSORS IN THE DISCHARGE OF THE BOX, PROVIDING BOX LEAVING AIR TEMPERATURE AS A TROUBLESHOOTING TOOL. PROVIDE COLOR GRAPHICS FOR ALL VAV BOXES, INCLUDING ALL DDC BOX CONTROLLER FUNCTIONS, PLUS BOX DISCHARGE ARE TEMPERATURE.

COLD DUCT DAMPER: During the occupied mode, the damper (CD-O) will modulate to provide cold air flow (CD-F) at or below maximum cold duct flow setpoint (CDFLOW-SP). Air flow setpoint (CDFLOW-SP) will be determined from zone temperature (ZN-T) and cooling setpoint (EFFCLG-SP) control loop. On a rise in zone temperature (ZN-T) cold air flow (CD-F) will increase. On a drop in zone temperature (ZN-T) cold air flow (CD-F) will decrease until the damper (CD-O) is closed.

HOT DUCT DAMPER: During the occupied mode, the damper (HD-O) will modulate to provide hot air flow (HD-F) at or below maximum hot duct flow setpoint (HDFLOW-SP). Air flow setpoint (HDFLOW-SP) will be determined from zone temperature (ZN-T) and heating setpoint (EFFHTG-SP) control loop. On a drop in zone temperature (ZN-T) hot air flow (HD-F) will increase. On a rise in zone temperature (ZN-T) the hot air flow (HD-F) will decrease until the damper (DPR-O) is closed.

TOTAL AIRFLOW: The total sum of hot deck (HD-F) and cold deck (CD-F) airflows will vary as scheduled and detailed.

UNOCCUPIED MODE: During the unoccupied mode of operation the sequence above will apply. However, the box will setback and setup the zone cooling (EFFCLG-SP) and heating (EFFHTG-SP) setpoints as well as reduce the air flow requirements.

DISCHARGE AIR TEMP SENSOR: A discharge air temp (DA-T) sensor is provided on each box for monitoring purposes.

UNIT ENABLE: A network unit enable (UNITEN-MODE) signal will control the mode of the box.

NETWORK WARMUP-COOLDOWN: Warm-up and cooldown modes will be activated by a network command (WC-C).

4.2 SINGLE DUCT VAV TERMINAL UNIT- NOTE THAT ALL EXISTING SINGLE DUCT VAV TERMINALS SHALL BE MODIFIED BY CHANGING THE ACTUATOR AND PNEUMATIC BOX CONTROLLER WITH A DDC BOX CONTROLLER COMPATIBLE WITH JOHNSON CONTROLS METASYS. WHERE BOXES ARE NEW, PROVIDE NEW DDC BOX CONTROLLERS AS SPECIFIED, MOUNTED AT THE FACTORY OR IN THE FIELD. ALL BOXES SHALL BE OUTFITTED WITH TEMPERATURE SENSORS IN THE DISCHARGE OF THE BOX, PROVIDING BOX LEAVING AIR TEMPERATURE AS A TROUBLESHOOTING TOOL. PROVIDE COLOR GRAPHICS FOR ALL VAV BOXES, INCLUDING ALL DDC BOX CONTROLLER FUNCTIONS, PLUS BOX DISCHARGE ARE TEMPERATURE.

OCCUPIED MODE: When the zone temperature (ZN-T) is between the occupied heating (EFFHTG-SP) and cooling (EFFCLG-SP) setpoints (inside of the bias), the primary air damper (DPR-O) will be at the minimum CFM (SA-F) and there will be no mechanical heating. On a rise in zone temperature (ZN-T) above the cooling setpoint (EFFCLG-SP), the primary air damper (DPR-O) will increase the CFM (SA-F) and there will be no mechanical heating. On a drop in zone temperature (ZN-T) below the heating setpoint (EFFHTG-SP), the reheat coil will be used to maintain the zone temperature (ZN-T) and the damper (DPR-O) is controlled to provide a minimum CFM (SA-F).

UNOCCUPIED MODE: When in this mode, while the zone temperature (ZN-T) is between the unoccupied heating (EFFHTG-SP) and cooling (EFFCLG-SP) setpoints (inside of the bias), the primary air damper (DPR-O) will be at the minimum CFM (SA-F) and there will be no mechanical heating. On a rise in zone temperature (ZN-T) above the unoccupied cooling setpoint (EFFCLG-SP), the primary air damper (DPR-O) will increase the CFM (SA-F) (if available) and there will be no mechanical heating. On a drop in zone temperature (ZN-T) below the unoccupied heating setpoint (EFFHTG-SP), the reheat coil will be used to maintain the zone temperature (ZN-T) and the primary air damper (DPR-O) will be at the minimum CFM (SA-F).

DISCHARGE AIR TEMP SENSOR: A discharge air temp (DA-T) sensor is provided on each box for monitoring purposes.

UNIT ENABLE: A network unit enable (UNITEN-MODE) signal will control the mode of the box.

NETWORK WARMUP-COOLDOWN: Warm-up and Cooldown modes will be activated by a network command (WC-C). When the zone temperature (ZN-T) is below the effective heating setpoint (EFFHTG-SP), the box damper will be modulated to allow warm air flow, then reheat coil to maintain the zone temperature (ZN-T). When the box effective heating setpoint is satisfied the flow will remain at the warm-up minimum position until the warm command has been removed.

4.3 RARE BOOKS ROOM CONTROL

The rare books room is specified to be provided with a specialty unit (AAON or Equal) to be installed with factory controls to control temperature and humidity. Refer to 237100 for sequence of operation and interface. JCI shall coordinate with the unit manufacturer to bring in through a gateway all alarm, control setpoints and maintenance messages. Create a color graphic for the unit with return air, dx coil air discharge temperature, reheat coil control via room thermostat, and display of all system alarms. Provide room temperature adjustment (network thermostat) with override from the front end of room temperature. Interface via MS/TP BACnet format. Coordinate with AAON prior to bid.

END OF SECTION 250000

SECTION 260100 – BASIC ELECTRICAL REQUIREMENTS

PART 1 – GENERAL

1.1 NOTE

A. The general provisions of the Contract including Uniform General Conditions and Supplementary General Conditions, Special Conditions and General Requirements (Division 01), apply to the work specified in this section.

1.2 SCOPE

A. The work included in Division 26 of the Specifications includes all electrical work, interior and exterior to the project. Provide all materials, labor, equipment, transportation, tools, permits, fees, and supervision to install, test and make operational the complete electrical systems.

1.3 QUALITY ASSURANCE

A. Referenced Standards: Provide and install products in accordance with referenced standards. Comply with the standards listed in each section.

B. Codes: The electrical work shall be in accordance with latest edition of the following codes:

1. National Electrical Code
2. National Electrical Safety Code
3. Life Safety Code
4. International Building Code
5. City of Lubbock Electrical Ordinance
6. State of Texas codes as applicable
7. National Fire Protection Association
8. Other codes as referenced in individual sections

C. Material Standards: Materials and equipment shall be listed or labeled as defined in Article 100 of the National Electrical Code (NEC), by a testing agency acceptable to the Owner. Materials shall be marked for their intended use.

D. Permits and Inspections: Obtain all permits and inspections for the installation of the work and pay all charges incident thereto. Deliver to the Owner all certificates of inspections issued by authorities having jurisdiction.

1.4 SUBMITTALS

A. Provide submittals for equipment as listed in each Section.

B. Submittals shall include descriptive material, catalog sheets, diagrams, performance curves, and charts published by the manufacturer to show conformance with drawings and specifications.

C. Provide complete electrical characteristics for all equipment. Lighting submittals shall include photometric data.

D. Submittals shall be clearly marked showing the individual item offered.

E. All electrical submittals shall be electronic format (pdf), indexed by specification section, and certified that they have been checked by the contractor.

F. Omissions from the submittal of any material which has been shown on the drawings or specified, does not relieve the contractor from furnishing and installing the item.

1.5 WARRANTY

A. The contractor warrants the material and equipment installed to be free from defects for a period of one year after acceptance by the owner. All defects in labor or materials occurring during this period shall be repaired or replaced.

PART 2 - PRODUCTS

2.1 EQUIPMENT REQUIREMENTS

A. The electrical equipment specified and shown on the drawings is based on information available at the time of design. If the equipment furnished has different electrical requirements, the contractor shall make the required changes to the wire, conduit, controls, overcurrent protection, switchgear, and installation as required to accommodate the equipment supplied, without additional charge to the owner. The cost for such adjustments shall be assigned to the respective section of this Specification under which the equipment is furnished.

2.2 MATERIALS

A. All materials shall be UL labeled where a Standard exists for the product. If the product does not bear the UL label, the manufacturer shall submit documentation from an independent testing laboratory, acceptable to the authority having jurisdiction, showing evidence that the product is suitable for the installation.

B. Materials and equipment shall be the standard products in current production of manufacturers regularly engaged in the production of such equipment.

C. All materials shall be new and free from defects. Materials of the same type shall be the product of one manufacturer.

D. All material and equipment shall be installed, applied, and handled in accordance with the manufacturer's recommendations and standards.

E. Where no specific material is mentioned, provide the required material from a reputable manufacturer. The material shall conform to the project requirements, and shall be suitable to the engineer.

PART 3 - EXECUTION

3.1 GENERAL

A. Fabricate, erect, and install the complete electrical systems in accordance with accepted good practice by qualified personnel who are licensed and experienced in such work. Proceed in an orderly manner so as not to impede the progress of the project.

B. Contractor shall provide and install all conduits and line voltage wiring for temperature controls. Coordinate exact requirements with mechanical and/or temperature controls contractor.

3.2 DRAWINGS

A. The electrical drawings are diagrammatic. Carefully coordinate the work with structural, architectural, and mechanical conditions. Make adjustments to avoid conflicts.

B. The locations shown for electrical equipment is approximate and not intended to convey the exact details of installation. Exact locations are to be determined in the field by actual measurements.

C. The contractor is responsible for fitting the equipment and material into the space. If the equipment furnished requires different space conditions than shown on the drawings, the contractor shall arrange for such space and shall submit a drawing indicating the exact details of installation prior to construction.

D. Do not scale drawings. Layout electrical equipment using dimensions obtained from the manufacturer of the equipment and from field measurements.

3.3 SITE INVESTIGATION

A. Prior to submitting bids, visit the site and become aware of existing conditions that may affect the cost of the project. Include in the bid the work required to remove, extend, relocate, reconnect or modify existing equipment or systems, and to restore them to their original condition.

3.4 MATERIALS HANDLING AND STORAGE

A. Handle materials in accordance with the manufacturer's standards and recommendations.

B. All materials, except those specifically designed to be installed outdoors, shall be stored in an enclosed, dry building or trailer. Protect all stored equipment from damage. Remove damaged materials from the premises.

C. Equipment and materials shall not be installed until such time as the environmental conditions of the job site are suitable to protect the equipment and materials. They shall be protected from water, direct sunlight, cold and heat unless designed for such conditions.

3.5 CUTTING AND PATCHING

A. Sleeve or cut all openings in walls, floors, ceilings and roof required to install the electrical work.

B. Do not cut structural members unless specific permission is granted by the structural engineer.

C. Patch all openings after installation of the work, and repair any damage caused by this activity. Restore the surface to its original condition.

3.6 PAINTING

A. Refer to PAINTING Section of these Specifications.

B. Touchup scratched or marred surfaces of all electrical equipment with paint obtained from the equipment manufacturers specifically for that purpose. Remove all oil, dirt, grease and foreign material before painting and prepare the surface as recommended by the manufacturer.

C. Where plywood backboards are used to mount equipment, paint backboards with two coats of light gray semi-gloss paint.

3.7 TESTING

A. Provide all field-testing specified in the individual specification sections.

3.8 RECORD DOCUMENTS

A. Provide record documents as required in Division 01 of the specifications.

3.9 OPERATION AND MAINTENANCE INSTRUCTIONS

A. Provide Operation and Maintenance manuals as required in Division 01 of the specifications.

B. Before final inspection, instruct the owner's personnel in operation of the systems under this Division. Use the Operation and Maintenance Manual as basis for the instruction. Review the contents of the manual in detail and explain all aspects of operation and maintenance.

C. Prepare and insert additional data in the manual when need for such data becomes apparent during instruction.

END OF SECTION 260100

SECTION 260518 – WIRES AND CABLES

PART 1 – GENERAL

1.1 NOTE

A. The general provisions of the Contract including Uniform General Conditions and Supplementary General Conditions, Special Conditions and General Requirements (Division 01), apply to the work specified in this section.

1.2 SUBMITTALS

A. Submit catalog data sheets on all conductors and cables and wire.

1.3 SCOPE

A. Under this Section, furnish and install all building wires and cables (600 volts and below) complete with connectors and terminations. Exterior branch circuits and feeders are also included in this section. Wiring for communication and alarm systems are included in their respective sections unless they reference this Section.

1.4 QUALITY ASSURANCE

A. Referenced Standards. Provide products which comply with the referenced standards. These Standards are incorporated into this Specification by reference.

1. National Fire Protection Association (NFPA)

   No. 70 National Electrical Code (NEC)

2. Underwriters Laboratories, Inc. (U.L.)

   UL 44 Thermoset-Insulated Wires and Cables

   UL 83 Thermoplastic-Insulated Wires and Cables

   UL 486 Wire Connectors and Soldering Lugs

   UL 510 Insulating Tape

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to project requirements, products manufactured by (but not limited to) the following companies are acceptable.

1. Insulated Cable:
   a. Southwire Co.
   b. Encore Wire Corporation

c. Okonite
d. General Cable

2. Electrical Spring Connectors:
   a. Scotch
   b. Ideal
   c. Buchanan
3. Compression Connectors:
   a. Burndy
   b. Scotch
   c. Ilsco
4. Mechanical Connectors:
   a. Burndy
   b. Scotch
   c. Ideal
5. Insulating Kits:
   a. Raychem
   b. Scotch
6. Insulating Tape: Scotch

2.2 CONDUCTORS

A. Type: Soft drawn copper, UL listed, rated at 600 volts, free from flaws and imperfections. Conductors no. 10 and smaller shall be solid. Conductors larger than no. 10 shall be stranded.

B. Insulation: Unless otherwise indicated on the drawings, otherwise specified in other Sections, or otherwise required by the National Electrical Code, conductors shall have type THHN/THWN-2 or XHHW insulation.

C. High Temperatures: Use type RHH or RHW-2 for wiring in proximity to boilers and other devices subject to high temperatures.

D. Markings: Conductors shall be marked on the surface with rated voltage, size, type, and manufacturer. The size shall be repeated at intervals not exceeding 24 inches, with the remaining data repeated at intervals not exceeding 40 inches.

E. Performance: Conductors shall be electrically continuous and free from shorts or grounds. All open or shorted conductors shall be replaced. All conductors with damaged insulation shall be removed and replaced with new conductors free from defects.

F. Conductors and cables installed open in ceiling plenums shall be plenum-rated.

2.3 JOINTS AND SPLICES

A. Solid Conductors (No. 10 AWG and smaller): U.L. approved, screw-on, electrical spring connectors, 600 volt, 105C, insulated.

B. Stranded Conductors (No. 8 and Larger): Crimp type compression connectors properly selected for the conductor size and material. All connectors shall be applied with properly sized dies and tools as recommended by the manufacturer. Insulate the splice with an insulating kit providing 600 volt, 90C rating.

2.4 COLOR CODING

A. Equipment Grounding Conductors:

1. Equipment grounding conductors shall be green. Grounding conductors from isolated grounding system shall be green with yellow stripes.
2. Equipment grounding conductors, no. 6 awg and smaller shall have continuous color-coding the entire length of the conductor. Sizes larger than no. 6 awg shall be permitted to be identified at each end, and at every point where the conductor is accessible. The marking shall consist of green tape, or green adhesive labels.

B. Neutral Conductors:

1. Neutral conductors shall be white or natural gray.
2. Where systems of different voltages are installed, the neutral of the lower voltage shall be white or natural gray, and the neutral of the higher voltage shall have three continuous white stripes on other than green insulation.
3. Sizes no. 6 awg, or smaller shall have continuous color-coding the entire length of the conductor. Larger sizes shall be permitted to be identified at each end, and at every point where the conductor is accessible. The marking shall consist of white tape or stripped tape or white adhesive labels.

C. Phase Conductors:

1. Conductors no. 10 awg and smaller shall have continuous color-coding the entire length of the conductor. Larger sizes shall be permitted to be identified at each

end, and at every point where the conductor is accessible. The marking shall consist of colored tape, or colored adhesive labels.

2. The color-coding system employed shall be permanently posted on the inside door of each branch-circuit panelboard. The posting shall identify the color-coding of each phase conductor and shall be applied to the inside of the door with adhesive.
3. 120/208 volt, 3 phase system:
   Phase A – Black
   Phase B – Red
   Phase C – Blue
4. 277/480 volt, three phase system:
   Phase A – Brown
   Phase B – Orange
   Phase C – Yellow

PART 3 – EXECUTION

3.1 INSTALLATION OF WIRING

A. Install all wiring in raceways unless specified otherwise.

B. Wire Pulling: Provide suitable installation equipment for pulling conductors into raceways or conduits. Use ropes of polyethylene, nylon or other suitable material to pull in conductors. Attach pulling lines to conductors by means of woven basket grips or by pulling eyes attached directly to conductors. All conductors to be installed in a single conduit shall be pulled in together. Use U.L. listed cable pulling compound where necessary.

C. Cable Lubricants: All cable lubricants shall be UL listed, and shall be certified by their manufacturer to be non-injurious to the insulation on which they are used.

D. Wire Sizing:
   1. No wire shall be smaller than no. 12, except for signal and control circuits, or lighting fixture taps.
   2. Receptacle and motor branch circuits – Use no. 12 conductors unless noted or scheduled otherwise.
   3. 120 volt, 20 amp lighting and receptacle branch circuits – Where the length of run from panelboard to first lighting outlet or receptacle exceeds 85 feet use no. 10 conductors; otherwise use no. 12.

4. 277 volt, 20 amp lighting branch circuit – Where the length of run from panelboard to first lighting outlet exceeds 175 feet, use no. 10 conductors; otherwise use no. 12.
5. Where more than three current-carrying conductors are installed in the same conduit or raceway, the conductors shall be increased in size as required to maintain the required ampacity after application of the adjustment factors of NEC Table 310-15(b)(2)(a).

E. Joints and Splices:
1. Make joints and splices only where necessary and only at outlet boxes, wiring troughs and other enclosures permitted by the NEC. All joints shall be mechanically and electrically secure.
2. Do not splice conductors in panelboards, safety switches, switchboards, motor control centers or motor control enclosures.
3. Conductors for use with insulated spring connectors shall be twisted together prior to application of the connector.

F. Terminations: Tighten electrical connections and terminations in accordance with the manufacturer's published values. A calibrated tool shall be used to insure proper torque values.

G. Bundling: Bundle all conductors in panelboards, cabinets, pullboxes and the like using nylon straps made for this purpose. Bundle conductors larger than no. 10 in individual circuits. Bundle smaller conductors in larger groups.

H. Identification: Refer to ELECTRICAL IDENTIFICATION SECTION.
1. Mark conductors to clearly identify each circuit by number. Securely attach to each conductor in each junction box, pull box, panelboard, etc.
2. The cover of each junction box and pullbox shall be marked with the designations of each circuit contained therein.
3. Where colored plastic tape is applied to conductors for identification, use half-lapped turns for a distance of 6 inches from the terminal points and in boxes where taps and splices are made. Apply the last two turns with no tension to prevent unwinding. Use 1-inch wide tape applied to avoid obscuring cable identification markings.

3.2 FIELD TESTING

A. Tests and procedures shall be in accordance with the applicable IPCEA standards. Furnish all instruments, equipment and personnel required for testing. Submit test data to the engineer on data sheets in a format that can be compared with future testing. All test data shall be included in the project operating manual.

B. Test wires and cables for electrical continuity and short circuits.

C. Prior to terminating, check each service and feeder conductor with megohmmeter to determine the insulation resistance with respect to ground and other phases. Applied potential shall be 1000 volts dc for 1 minute.

D. Test cable mechanical connections to the manufacturer's recommended values using calibrated torque wrench.

E. Energize circuits and demonstrate proper operation.

END OF SECTION 260518

SECTION 260525 – GROUNDING AND BONDING

PART 1 – GENERAL

1.1 NOTE

A. The general provisions of the Contract including Uniform General Conditions and Supplementary General Conditions, Special Conditions and General Requirements (Division 01), apply to the work specified in this section.

1.2 SUBMITTALS

A. Submit product data sheets for all grounding equipment.

1.3 SCOPE

A. Furnish and install grounding equipment and systems as specified herein. Also refer to and comply with specific grounding requirements contained in other Sections.

1.4 QUALITY ASSURANCE

A. Referenced Standards: Provide products that comply with the referenced standards. These Standards are incorporated into this Specification by reference.

1. National Fire Protection Association (NFPA)

   No. 70 National Electrical Code (NEC)

2. Institute of Electrical and Electronic Engineers (IEEE)

   Standard 81 Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

3. Underwriters Laboratories, Inc. (UL)

   UL 467 Grounding and Bonding Equipment

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Subject to project requirements, products manufactured by (but not limited to) the following companies are acceptable:

1. Grounding Products:
   a. Chance / Hubbell
   b. Copperweld Corp
   c. Erico Inc.
   d. Ideal Industries, Inc.

e. ILSCO
f. Kearney / Cooper Power Systems
g. Lyncoln XIT Grounding
h. Superior Grounding Systems, Inc.
i. Thomas and Betts
j. Raco, Inc.
k. Burndy

2.2 CONDUCTORS

A. Equipment Grounding Conductors:
1. Use insulated conductors that comply with WIRES AND CABLES Section.
2. Equipment grounding conductors shall be green.
3. Isolated ground conductors shall be green with yellow stripes.
4. No. 6 AWG and smaller shall have continuous color-coding the entire length of conductor. Larger sizes shall be identified with color-coded plastic tape at each end, and at every point where the conductor is accessible. For equipment grounding conductors use green tape. For isolated ground conductors use alternating bands of green and yellow tape with a minimum of three bands of green and two bands of yellow.

B. Grounding Electrode Conductors: Insulated stranded cable complying with WIRES AND CABLES Section.

C. Underground Ground Conductors: Bare conductors installed underground shall be tinned, stranded complying with ASTM B8.

D. Bonding Conductors:
1. Bonding cable: 28 kcmil, 14 strands of no. 17 AWG, copper.
2. Bonding Conductor: Bare stranded copper.
3. Bonding Jumper: Bare copper tape, braided bare copper conductors terminated with copper ferrules.

2.3 GROUND CONNECTORS

A. Compression Connectors:
1. Suitable for direct burial, embedded in concrete, or above grade applications, equal to Burndy Hyground.

2. Connectors shall be equivalent in current-carrying capacity to the maximum size copper conductors being joined.
3. Equipment shall be in accordance with the connector manufacturers recommendation. This shall include cable preparation, installation tools and dies, and the required number of crimps.

B. Bolted Connectors:
1. UL listed for grounding.
2. Above grade applications.
3. Provide equipment in accordance with connector manufacturers' recommendations for the application.

C. Welded Connectors:
1. Exothermic-welded type, UL listed for grounding connections.
2. Provided in kit form and selected for the specific types, sizes, conductors and other items to be connected.

PART 3 – EXECUTION

3.1 EQUIPMENT GROUNDING CONDUCTORS

A. Comply with NEC Article 250 for types, sizes and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NEC are indicated.

B. Install a separate, green-insulated, equipment grounding conductor in each feeder and each branch conduit. Install the grounding conductor in the same raceway with related phase and neutral conductors, and connect to pull boxes or outlet boxes at intervals of 100 feet or less. Where paralleled conductors in separate raceways occur, provide a grounding conductor in each raceway. Connect the grounding conductors to bare grounding bars in panelboards, and ground busses in service equipment to the end that there will be an uninterrupted grounding circuit from the point of a ground fault to the point of connection of the equipment ground and system neutral.

C. Install equipment grounding conductors in nonmetallic raceways unless they are designated for telephone or data cables.

D. Install equipment grounding conductors in all flexible metal conduit and liquid-tight flexible metal conduit.

3.2 GROUNDING DRY-TYPE TRANSFORMER

A. Ground the secondary neutral point and the housing of each dry-type transformer. Connect these items together within the transformer housing and run a common grounding conductor from their point of connection to a point of grounding. The grounding electrode shall be in order of preference:

1. The nearest available effectively grounded structural metal member of the building; or
2. The nearest available effectively grounded metal water pipe 2 inches or larger in diameter; or
3. Other electrodes as specified in National Electrical Code Sections 250-82 and 250-83 where the above described electrodes are not available.

3.3 FIELD INSPECTION AND TESTING

A. Inspection:

1. Visually verify proper grounding connections at the service entrance equipment.
2. Visually verify proper connections to the grounding electrode system.
3. Visually verify proper grounding connections of separately derived systems.
4. Visually verify proper grounding connections at emergency generators.
5. Visually verify proper grounding connections at distribution panels and branch circuit panels.

END OF SECTION 260525

SECTION 260532 – RACEWAYS

PART 1 – GENERAL

1.1 NOTE

A. The general provisions of the Contract including Uniform General Conditions and Supplementary General Conditions, Special Conditions and General Requirements (Division 01), apply to the work specified in this section.

1.2 SUBMITTALS

A. Submit product data sheets for all conduits and fittings.

1.3 SCOPE

A. Furnish and install all conduits, wireways, raceways, and fittings for all systems interior and exterior to the building.

1.4 QUALITY ASSURANCE

A. Referenced Standards: Provide products that comply with the referenced standards. These Standards are incorporated into this Specification by reference.

1. National Fire Protection Association (NFPA)
   - No. 70 National Electrical Code (NEC)
2. American National Standards Institute (ANSI)
   - C-80.1 Rigid Galvanized Conduit
   - C-80.3 Electrical Metallic Tubing
3. Underwriters Laboratories, Inc. (UL)
   - UL 1 Flexible Metal Conduit
   - UL 5 Surface Metal Raceways and Fittings
   - UL 6 Rigid Metal Conduit
   - UL 651 Rigid PVC Conduit
   - UL 797 Electrical Metallic Tubing
   - UL 1242 Intermediate Metal Conduit
   - UL 360 Liquid-Tight Flexible Steel Conduit
4. National Electrical Manufacturers Association (NEMA)
   - RN1 Externally PVC Coated GRS and IMC Conduit

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to project requirements, products manufactured by (but not limited to) the following companies are acceptable:

1. Metal Conduit and Fittings:
    a. Allied
    b. Wheatland
    c. Appleton
    d. Raco
    e. Killark
    f. O-Z / Gedney
2. PVC Coated Metal Conduit:
    a. Robroy Industries
    b. Levy

2.2 METAL CONDUIT AND FITTINGS

A. Rigid Steel Conduit (GRS):

1. Rigid, threaded, galvanized inside and outside or galvanized outside with protective coating inside.
2. Factory made steel threaded couplings.

B. Intermediate Metal Conduit (IMC):

1. Rigid, threaded, thin wall steel, galvanized outside with protective coating inside.
2. Factory made steel threaded couplings.

C. Electrical Metallic Tubing (EMT):

1. Steel tubing, galvanized outside with slick corrosion resistant interior coating.
2. Steel compression couplings and box connectors with insulated throats.

D. Flexible Metal Conduit:

1. Spirally wound with interlocking galvanized steel strips. Aluminum is not permitted.
2. Flexible conduit shall be approved for use as equipment grounding conductor.
3. Connectors shall be steel, suitable for grounding continuity.

E. Liquidtight Flexible Metal Conduit:

1. Spirally wound with interlocking galvanized steel strips with PVC cover extruded over the exterior to make the conduit liquidtight.

2. Shall be approved for use as equipment grounding conductor.
3. Shall be steel, suitable for grounding continuity, liquidtight.

2.3 PVC COATED METAL CONDUIT AND FITTINGS

A. PVC coating shall be bonded to the galvanized outer surface of the conduit, minimum 20 mil thick.

B. Couplings shall have PVC coating with PVC sleeve extending from both ends such that joining the coupling and conduit will cover all metal surfaces.

PART 3 – EXECUTION

3.1 INSTALLATION OF PVC COATED CONDUITS

A. During installation, visually examine the conduit for cuts. Patch these areas with a paste containing a PVC solvent obtained from the conduit manufacturer. The patch shall be built up to the original thickness of the coating and feathered out on all sides of the damaged area a minimum of l/2 inch to provide a complete bonded seal over the damaged area.

3.2 INSTALLATION OF BUILDING RACEWAYS

A. All wiring of every description shall be run in conduit or electrical metallic tubing unless noted or specified otherwise. Conduits may be run exposed in machinery and electrical rooms and unfinished areas. All other conduits shall be run concealed unless otherwise noted. All exposed runs shall be installed parallel to the surface of the building in a neat and orderly manner.

B. Types: All conduits installed in wet or damp locations, or on roofs shall be rigid galvanized steel conduits. Above grade interior conduits shall be rigid galvanized steel conduit, intermediate metal conduits or electrical metallic tubing. Conduits installed below grade in slabs or buried in earth shall be PVC or PVC coated rigid galvanized steel or wrapped rigid galvanized steel.

C. Sizes: Size and install raceways so that conductors may be drawn in without injury or excessive strain. Make field bends with approved bending devices. Do not install bends or offsets in which conduit is crushed, deformed or otherwise injured.

D. Connections: Use lengths of flexible metal conduit, not less than 12" long at final connections to all motors, generators, controls and other devices subject to movement because of vibration or mechanical adjustment. Use flexible metal conduit also at

connections to recessed lighting fixtures, and elsewhere as required. In damp or wet locations, and where installed outdoors, use liquidtight flexible metal conduit.

E. Around Heat Producing Equipment: Do not install raceways within 3" of steam and hot water pipes, breeching and flues, except where crossings are unavoidable, and then keep raceways at least 1" from insulation on the pipe, breeching or flue crossed. Wherever possible, avoid installing raceways directly above or in close proximity to boilers and other like objects operating at high temperatures.

F. Damp or Wet Locations: In damp or wet locations make every effort to avoid installing raceways in a manner which will create moisture traps. Where they must be so installed, seal both ends of raceways with an approved sealing compound to prevent "breathing" and moisture condensation within the raceways.

G. Different Systems: In systems operating at more than 300 volts between phase conductors, where different phase conductors are to be run to a common gang wall switch box, install a separate conduit for each different phase wire and its return switch leg, and provide substantial barriers between adjacent switches in the box so that two different phase wires will not be the same compartment.

H. Joining Rigid Conduits: Join with threaded couplings. Ream out all conduit ends after threading. Secure rigid conduits at panel boxes, junction boxes, pull boxes, switchboards, support boxes, or sheet metal outlet boxes by galvanized locknuts, inside and outside, with insulating bushing inside. Unthreaded set screw type couplings or connectors are not acceptable in rigid conduit systems. No running threads shall be used anywhere in conduit systems.

I. Protection of Raceways: Seal ends of all raceways with blank discs ("pennies"), push pennies or other approved closers during construction. Do not pull any conductors into raceways until all plastering in the vicinity is completed. Swab out all raceways before pulling in conductors.

J. Penetrations: Wherever raceways pass through floors, walls partitions, etc., carefully fill any space between the outside of the raceway and the building material to prevent passage of air, water, smoke and fumes. Filling material shall be fire-resistive and installed to meet requirements of the UL Fire Resistance Directory.

3.3 CONDUIT SUPPORTS

A. Support Spacing: Use minimum spacing as directed by National Electrical Code, but space hangers more closely where required by conditions.

B. Vertical Conduit Risers: Support vertical conduits at each floor by means of riser clamps or U-bolts, clamping them to a steel channel bridging the opening in the floor.

C. Individual Conduits: Support conduits running vertically or horizontally with galvanized malleable iron one hole clamps. Carry individually supported horizontal conduits l-1/4" and larger on Kindorf No. 150 or Steel City No. C-149 hangers. Use no perforated strap iron as hanger material. Where conduits smaller than 1-1/4" are installed above metal lath and plaster ceilings or mechanically suspended dry ceilings of the non-removable type, they may be supported on ceiling runner channels. Where conduits smaller than 1-1/4" are installed above removable ceilings, attach them to the structure or bar joists (where present) or support them on threaded hanger rods with clips. Do not use any wire to support conduits or to attach conduits to supporting members. Locate conduits a sufficient distance above the ceiling to permit removal of the ceiling panels. Locate them so as not to hinder access to mechanical and electrical equipment through the ceiling panels.

D. Multiple Conduits: Where multiple raceways are run horizontally at the same elevations, they may be supported on trapezes formed of sections of Unistrut angle iron or channels suspended on rods or pipes. Size trapeze members including the suspension rods for the number size and loaded weight of the conduits they are to support. Space them as required for the smallest conduit supported.

END OF SECTION 260532

SECTION 260534 – BOXES

PART 1 – GENERAL

1.1 NOTE

A. The general provisions of the Contract including Uniform General Conditions and Supplementary General Conditions, Special Conditions and General Requirements (Division 01), apply to the work specified in this section.

1.2 SUBMITTALS

A. Submit catalog data sheets for all boxes.

1.3 SCOPE

A. Furnish and install electrical boxes in accordance with the requirements of the National Electrical Code.

1.4 QUALITY ASSURANCE

A. Referenced Standards. Provide products that comply with the referenced standards. These Standards are incorporated into this Specification by reference.

1. National Fire Protection Association (NFPA)
   - No. 70 National Electrical Code (NEC)
2. Underwriters Laboratories, Inc. (UL)
   - No. 514 Outlet boxes and fittings
   - No. 50 Enclosures for Electrical Equipment
3. National Electrical Manufacturers Association (NEMA)
   - No. OS 1 Sheet Steel Outlet Boxes, Device Boxes, Covers and Box Supports
   - No. FB 1 Fittings and Supports for Conduit and Cable Assemblies

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to project requirements, products manufactured by (but not limited to) the following companies are acceptable.

1. Sheet Steel Outlet and Device Boxes:
   a. Raco
   b. Steel City
   c. Appleton

2. Cast Metal Device Boxes:
    a. Crouse Hinds
    b. Appleton
    c. Pyle National

2.2 OUTLET AND DEVICE BOXES

A. All boxes shall be UL listed.

B. Sheet steel boxes shall be not lighter than 14 gauge, galvanized after fabrication.

C. Cast metal boxes shall be cast iron or cast alloy.

D. Outlet boxes for switches, receptacles and communications use shall be 4” square with proper square cornered tile wall cover, plaster cover or finishing plate, except where construction will not permit or the device requires a larger box. Box depth shall be as required by NEC for device and wiring volume requirements, but not smaller than 1-1/2 inches.

E. Boxes for devices mounted flush in concrete block walls shall be single gang masonry boxes, 3-1/2” deep.

F. Boxes installed in poured concrete shall be concrete-tight type.

G. Boxes for surface mounted or pendant fixtures shall be 4”octagonal by 1-1/2” minimum depth.

H. Boxes for flush mounted fixtures shall be 4” by 4” size with cover installed above the ceiling and accessible by removing ceiling panel or fixture. Connection to fixture shall be with flexible conduit.

I. Boxes for interior exposed work shall be cast metal boxes (Cast iron or cast alloy).

J. Boxes for outdoors shall be cast metal boxes with gasketed covers.

2.3 PULLBOXES AND JUNCTION BOXES

A. Sheet steel galvanized inside and outside, with galvanized covers.

B. Dimensions shall be as required by NEC for the number, size and locations of conduits entering the box.

C. Boxes installed above ceilings shall be accessible by removing ceiling panels, installing access door in hard ceiling, or flush mounting the cover on the ceiling.

D. Boxes installed flush in walls in finished areas shall have overlapping trim with hinged door and lock to match the appearance of electrical panelboard.

E. All boxes shall have covers.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Provide at each outlet or device of whatever character a metal outlet box in which conduits shall terminate.

B. All pull and junction boxes shall be accessible after construction is complete. Install access panels in the construction as required to make the box accessible.

C. Fasten all boxes securely to the building construction, independent of conduit systems.

D. Where outlet box on grid ceiling supports surface or suspended fixture, provide box with fixture stud and secure the box to ceiling members with steel channel.

E. Outlet boxes for devices shown back to back shall be offset a minimum of 6 inches.

F. All boxes shall have covers and unused conduit openings shall be covered.

END OF SECTION 260534

SECTION 260552 – ELECTRICAL IDENTIFICATION

PART 1 – GENERAL

1.1 NOTE

A. The general provisions of the Contract including Uniform General Conditions and Supplementary General Conditions, Special Conditions and General Requirements (Division 01), apply to the work specified in this section.

1.2 SCOPE

A. Provide and install electrical identification for electrical conductors and equipment.

1.3 QUALITY ASSURANCE

A. Comply with National Electrical Code (NEC).

B. Comply with UL Standard 969.

C. Comply with ANSI C2.

D. Comply with NEMA WC-1 and WC-2.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to project requirements, products manufactured by (but not limited to) the following companies are acceptable.

1. W. H. Brady
2. Ideal Industries, Inc.
3. Seton Nameplate Co.
4. Panduit Corp.

2.2 EQUIPMENT NAMEPLATES AND SIGNS

A. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.

B. Engraved Plastic Nameplates:

1. Melamine plastic laminate, minimum 1/16” thick for signs up to 20 sq. inches, and 1/8” thick for larger sizes.
2. White letters on black face for equipment connected to normal power system.
3. White letters on red face for equipment connected to emergency power system.
4. Attach with self-tapping stainless-steel screws, except contact-type permanent adhesive can be used where screws can not or should not penetrate the surface.

2.3 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coded Plastic Tape: Provide manufacturer's standard self-adhesive vinyl tape not less than 3 mils thick by 1-1/2" wide.

B. Identification Bands: Provide manufacturer's standard vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters to show circuit identification.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install electrical identification products in accordance with the manufacturer's written instructions, and requirements of NEC and OSHA.

B. For items attached with adhesive, degrease and clean the surface as recommended by the manufacturer.

C. Where items attach to surfaces that require painting, attach after completion of painting.

D. Install signs at locations for most convenient viewing without interference with operation and maintenance of equipment.

E. Identification on Boxes:

1. Boxes for fire alarm circuits shall be painted red.
2. Every box containing circuit wiring shall have the circuit numbers marked on the outside cover of the junction box. Use indelible marker with wide tip. Markings for normal circuits shall be black, and shall be red for emergency circuits.

3.2 CONDUCTOR IDENTIFICATION

A. Apply conductor identification on each conductor in each box, enclosure, cabinet and panel.

B. Refer to Section 260518, WIRES AND CABLES for color-coding of conductors.

3.3 EQUIPMENT IDENTIFICATION

A. Install engraved, plastic laminate sign on each unit of electrical equipment, including central or master unit of each system. This includes power, lighting, communication, signal, and alarm systems unless the units contain their own self-explanatory identification.

B. Unless otherwise indicated, provide a single line of text with ½" high lettering on 1-1/2" high sign (2" high where 2 lines are required).

C. Text shall match the notations used on the drawings for identification.

3.4 IDENTIFICATION OF PANELBOARDS, SWITCHBOARDS, AND SWITCHGEAR

A. Install engraved plastic laminate sign containing 3 lines of text. The top line shall be the panel name. The centerline shall indicate the panel voltage, and the bottom line shall indicate the source of supply.

B. Signs for equipment fed from the normal system shall have white letters on black background, and equipment fed from the emergency system shall have white letters on red background.

C. An example of the required identifications is:

Panel 4HA

277/480

Fed From Panel 4DP

END OF SECTION 260552

SECTION 260943.13 – DIGITAL-NETWORK LIGHTING CONTROLS

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:

1. System Software Interfaces.
2. System Backbone and Integration Equipment.
3. Wired Networked Devices.

B. Related Requirements:

1. Div. 26: Section 260100 "Basic Electrical Requirements" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 262726 "Wiring Devices" for wired switches and dimmers and other Project requirements applicable to Work specified in this Section.

1.2 DEFINITIONS

A. Global: Communication between devices in otherwise separate spaces using a bridging device or system controller.

B. Group: A set of devices that communicate together.

C. Scene: Digital light level associated with a preset.

D. System Backbone: Devices used to connect and manage otherwise separate spaces, including bridging devices and gateways or system controllers. Used to expose devices to software configuration via TCP/IP.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Coordination Meeting: Conduct conference Remote via Microsoft TEAMS before construction activity.

1. Attendees: Installers, fabricators, representatives of manufacturers, and administrants for field tests and inspections.
2. Engage factory-authorized service representative to attend preinstallation conference and review the submittal drawing, sequence of operation, and device installation best practices with Project team.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Bill of Materials necessary to install the networked lighting control system.
2. Product Specification Sheets indicating general device descriptions, dimensions, electrical specifications, wiring details, and nomenclature.
3. Information Technology (IT) connection information pertaining to interconnection with facility IT networking equipment and third-party systems.
4. Other Diagrams and Operational Descriptions - as needed to indicate system operation or interaction with other system(s).

B. Shop Drawings: Riser Diagrams showing device wiring connections of system backbone and typical per room/area type.

1.5 INFORMATIONAL SUBMITTALS

A. Contractor Startup/Commissioning Worksheet.

B. Service Specification Sheets indicating general service descriptions, including startup, training, post-startup support, and service contract terms.

C. Field quality-control reports.

D. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Contracts:

1. Hardware and Software Operation Manuals
2. Maintenance service agreement.
3. Software service agreement.

B. Warranty documentation.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Phone Support: Toll-free technical support available from manufacturer through an online tool to schedule a technical support appointment and provide 24/7 emergency support.
2. Remote Support: Manufacturer capable of providing remote support and ability to virtually connect with customers to address issues with visual guidance overlaid on images of real-world objects.

3. Cellular Connectivity: Manufacturer capable of cellular connectivity to a networked lighting control systems available to provide remote support within the continental United States.
4. On-Site Support: Manufacturer capable of providing a 72-hour, on-site response time within the continental United States.
5. Service Contracts: Manufacturer capable of providing service contracts for continued on-site and remote support of the lighting control system post-installation for terms up to 10 years from substantial completion, including:
    a. Remote and on-site emergency response.
    b. Remote system performance checks.
    c. Remote diagnostics.
    d. Replacement parts.

1.8 WARRANTY

A. Warranty: Manufacturer and Installer warrant that installed lighting control devices perform in accordance with specified requirements and agree to repair or replace, including labor, materials, and equipment, devices that fail to perform as specified within extended warranty period.
1. Failures include, but are not limited to, the following:
    a. Faulty operation of lighting control hardware.
    b. Faulty operation of lighting control firmware.
2. Minimum Warranty Period: Five years from date of shipment.

PART 2 – PRODUCTS

2.1 SYSTEM COMPLIANCE

A. System components manufactured in accordance with UL 916 and UL 924 standards where applicable.
B. System components manufactured in accordance with CFR Title 47, Part 15 standards where applicable.
C. System components manufactured in accordance with ISED Canada RSS-247 standards where applicable.
D. System components manufactured in accordance with IFT-008-2015 and NOM-208-SCFI-2016 standards where applicable.

E. System listed as qualified under DesignLights Consortium Networked Lighting Control System Specification v5.0.

F. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 SYSTEM PERFORMANCE REQUIREMENTS

A. System Architecture:

1. System architecture based upon the following concepts:
   a. Networkable intelligent lighting control devices.
   b. Standalone lighting control zones using distributed intelligence.
   c. Optional system backbone for remote, time-based, and global operation.
2. Intelligent lighting control devices with individually addressable network communication capability and having one or more basic lighting control components including: occupancy sensor, photosensor, relay, dimming output, contact closure input, analog 0-10 V(dc) input, and manual wall station capable of indicating switching, dimming, and/or scene control. Combining one or more of these components into a single device enclosure permissible to minimize overall system device count.
3. System capable of interfacing directly with networked luminaires such that either low-voltage network cabling or wireless RF communication is used to interconnect networked luminaires with control components such as sensors, switches, and system backbone.
4. Networked luminaires and intelligent lighting control devices support individual (unique) configuration of device settings and properties, with such configuration residing within the networked luminaires and intelligent control devices.
5. Lighting control zones consisting of one or more networked luminaires and intelligent lighting control devices capable of providing automatic control from sensors (occupancy and/or photosensor) and manual control from local wall stations without requiring connection to a higher-level system backbone.
   a. Lighting control zones (wired and wireless) support at least 128 devices per zone.

b. Capable of being networked with a higher-level system backbone to provide time-based control, control from inputs or systems external to control zone, and remote configuration and monitoring through a software interface.

6. Networked luminaires and intelligent lighting control devices with distributed intelligence programming stored in non-volatile memory, such that following any loss of power the lighting control zones operate according to their defined default settings and sequence of operations.
7. System to include one or more system controllers that provide time-based control.
8. System controller provides means of connecting the lighting control system to a system software interface and building management systems via BACnet/IP or BACnet MS/TP protocol.
9. System controller supports both low-voltage wired and wireless RF communication within a single controller device.
10. System devices support firmware update, either remotely or from within the application space, for purposes of upgrading functionality at a later date.
11. System capable of reporting lighting system events and performance data to management software for display and analysis.

B. Wired Networked Control Zone Characteristics:

1. Connections to devices within a wired networked lighting control zone and to backbone components accomplished with a single type of low-voltage network cable, compliant with CAT5e specifications or higher. Use of mixed types of low-voltage network cables is unacceptable.
2. Devices connected in "daisy-chain" topology. "Hub-and-spoke" topology, requiring all individual networked devices to be connected to a central component, is unacceptable, to reduce the total amount of network cable required for each control zone.
3. Pre-terminated, plenum-rated, low-voltage network cabling supplied with hardware.
4. Following proper installation and provision of power, all networked devices connected with low-voltage network cable must automatically form a functional lighting control zone without requiring any type of programming, regardless of the programming mechanism (e.g. software application, handheld remote, pushbutton).

a. The "out of box" default sequence of operation is intended to provide typical sequence of operation to minimize the system startup and programming requirements and to also have functional lighting control operation prior to system startup and programming.

5. System software capable of automatic discovery of all connected devices without requiring any provisioning of system or zone addresses.
6. Networked devices capable of detecting improper communication wiring and LED notification to alert installation/startup personnel.
7. Networked control devices suitable for control of egress or emergency light sources without additional, externally mounted UL 924 shunting or 0-10 V(dc) disconnect devices, to provide a compliant sequence of operation while reducing the overall installation and wiring costs of the system. Capable of supporting the following sequence of operation:
    a. Low-Voltage Power Sensing: Devices automatically provide 100 percent light level upon detection of loss of power sensed via low-voltage network cable connection where applicable.
    b. Line-Voltage Power Sensing: Devices listed as UL 924 emergency relays which automatically close load-control relay and provide 100 percent light output upon detection of loss of power sensed via line voltage connection to normal power.
8. Global Control Zones: Networked luminaires and intelligent lighting control devices located in different areas able to transmit and track information within at least 128 system-wide control zones to support required sequences of operation that may span multiple areas. Occupancy, photosensor inhibit, and switch commands available across multiple controllers.
9. Wired Networked Wall Station Scene-Control Capabilities:
    a. Preset Scenes that activate a specific combination of light levels across multiple local and global channels.
    b. Local Profile Support: Profile Scenes that modify the sequence of operation for devices in the area (group) in response to a button press to dynamically optimize occupant experience and lighting energy usage.

1) Wall stations able to manually start and stop local profiles, or local profile capable of ending after a specific duration of time between five minutes and 12 hours.
2) Configurable Parameters:
a) Fixture light level.
b) Occupancy time delay.
c) Response to occupancy sensors (including enabling/disabling response).
d) Response to daylight sensors (including enabling/disabling response).
e) Enabling/disabling wall stations.

c. Three-Way or Multi-Way Control: Multiple wall stations capable of controlling the same local and global control zones, to support "multi-way" preset scene and profile scene control.

C. System Integration Capabilities:

1. Capable of interface with third-party building management systems (BMS) to support two-way communication using BACnet/IP protocol, BACnet MS/TP protocol, and RESTful API including the following system integration capabilities:
a. "Write" messages for control of individual devices, including control of relay and dimming output.
b. "Write" messages for control of groups of devices through a single command, including control of relay and dimming output of all devices.
c. "Read" messages for individual device status information.
1) Available status will vary based on device type and capabilities, which may include relay state, dimming output, power measurement, occupancy sensor status, and photosensor light measurement.
d. "Read" messages for group status information for occupancy, relay state, and dimming output.
e. Activation of pre-defined system Global Profiles.

D. Supported Sequence of Operations:

1. Control Zones:

a. Local Control Zones: Networked luminaires and intelligent lighting control devices installed in an area (also referred to as a group of devices) capable of transmitting and tracking occupancy sensor, photosensor, and manual switch information within at least 48 unique control zones to support different and reconfigurable sequences of operation within area. These will also be referred to as local control zones.

b. Adjacent Control Zones: Networked luminaires and intelligent lighting control devices capable of tracking occupancy broadcasts from adjacent zones. When this feature is enabled, luminaire output for a vacant zone will reduce to a configurable dimmed state if one or more adjacent zones are occupied. Luminaires will turn off when both primary and adjacent zones are vacant.

c. Global Control Zones: Networked luminaires and intelligent lighting control devices located in different areas able to transmit and track information within at least 128 system-wide control zones to support required sequences of operation that may span across multiple areas. Occupancy, photosensor inhibit, and switch commands available across multiple controllers.

2. Wall Station Capabilities:

a. Wall stations support the following capabilities:

1) On/Off of a local or global control zone.

2) Continuous dimming control of light level of a local or global control zone.

b. Multi-Way Control: Multiple wall stations capable of controlling the same local or global control zones, to support "multi-way" switching and dimming control.

3. Occupancy Sensing Capabilities:

a. Occupancy sensors configurable to control a local or global zone.

b. Multiple occupancy sensors capable of controlling the same local or global zones. This capability combines occupancy sensing coverage from multiple sensors without consuming multiple control zones.

c. Occupancy sensing sequence of operation modes:

1) On/Off Occupancy Sensing.

2) Partial-On Occupancy Sensing.
3) Partial-Off Occupancy Sensing.
4) Vacancy Sensing (Manual-On / Automatic-Off).

d. On/Off, Partial-On, and Partial-Off Occupancy Sensing Modes Sequence of Operation:
1) Occupancy automatically turn lights on to a designated level when occupancy is detected. Designated occupied light level support at least 100 dimming levels.
2) Occupancy sensors automatically turn lights off or to a dimmed state (Partial-Off) when vacancy occurs or if sufficient daylight is detected. Designated unoccupied dim level support at least 100 dimming levels.
3) System capable of combining Partial-Off and Full-Off operation by dimming lights to a designated level when vacant and turning the lights off completely after an additional time delay.
4) Photosensor readings, if enabled in occupancy sensing control zone, automatically adjust light levels during occupied or unoccupied conditions as necessary.
5) Wall station activation changes the dimming level or turn lights off as selected by the occupant. Lights optionally remain in this manually specified light level until the zone becomes vacant. Upon vacancy, normal sequence of operation resumes.

e. Vacancy Sensing or Manual-On/Automatic-Off Mode Sequence of Operation:
1) Activation of a wall station is required turn lights on. System capable of programming the zone to turn on to either a designated light level or previous user-set light level. Initially occupying the space without using a wall station must not result in lights turning on.
2) Occupancy sensors automatically turn lights off or to a dimmed state (Partial-Off) when vacancy occurs or if sufficient daylight is detected. Designated unoccupied dim level support at least 100 dimming levels.
3) System capable of dimming the lights when vacant and then turning the lights off completely after an additional time delay.

4) System capable of an "automatic grace period" immediately following detection of vacancy, during which time any detected occupancy results in the lights reverting to the previous level. After the grace period has expired, the use of a wall station is required to turn lights on.

5) Photosensor readings, if enabled in the Occupancy Sensing control zone, capable of automatically adjusting the light level during occupied or unoccupied conditions as necessary.

6) Wall station interaction changes the dimming level or turn lights off as selected by occupant. Lights remain at manually specified light level until zone becomes vacant; normal sequence of operation resumes upon vacancy.

f. Occupancy time delays before dimming or shutting off lights separately programmable for all control zones from 15 seconds to 2 hours.

4. Photosensor Sensing Capabilities (Automatic Daylight Sensing):
   a. Photosensor devices configurable to control a local zone.
   b. Photosensor-Based Control:
      1) Continuous Dimming: Control zone automatically adjusts dimming output in response to photosenor readings, to maintain a minimum light level consisting of both electric light and daylight sources. Photosensor response configurable to adjust set point and dimming rates.
5. Schedule Capabilities:
   a. System capable of time schedules for time-of-day to override devices including offsets from dusk and dawn.
   b. System capable of providing a visible "blink warning" five minutes prior to the end of the schedule.
   c. Wall stations may be programmed to provide timed extensions/overrides that turn the lights on for an additional time period.
      1) Timed override/extension duration programmable for each individual device, zone of devices, or customized group of devices, from five minutes to 12 hours.

6. Global Profile Capabilities:
    a. System capable of automatically modifying the sequence of operation for selected devices in response to any of the following:
        1) Time-of-day schedule.
        2) Contact closure input state.
        3) Manually triggered wired wall station input.
        4) RS-232/RS-485 command to wired input device.
        5) BACnet input command.
    b. Global Profile Capabilities:
        1) Global Profiles stored within and executed from the system controller (via internal timeclock). Dedicated software host or server is not required to be online to support automatic scheduling and/or operation of Global Profiles.
        2) Global Profile time-of-day schedules capable of recurrence settings including daily, specific days of week, every "n" number of days, weekly, monthly, and yearly. Lighting control global profile schedules support definition of start date, end date, end after "n" recurrences, or never ending.
        3) Daylight savings time adjustments capable of being performed automatically, if desired.
        4) Global Profile holiday schedules follow recurrent settings for specific U.S. holiday dates regardless if they always occur on a specific date or are determined by day/week of the month.
        5) Global Profiles capable of being scheduled to run according to timed offsets relative to sunrise or sunset. Sunrise/sunset times automatically derived from location information using an astronomical clock.
        6) Software management interface capable of displaying a graphic calendar view of profile schedules for each control zone.
        7) Global Profiles capable of manual activation directly from system controller, specially programmed wired input devices, scene-capable wired wall stations, and software management interface.

8) Global Profiles selectable to apply to a single device, zone of devices, or customized group of devices.

9) Global Profile Configurable Parameters:

a) Fixture light level.

b) Occupancy time delay.

c) Response to occupancy sensors (including enabling/disabling response).

d) Response to daylight sensors (including enabling/disabling response).

e) Enabling/disabling of wall stations.

c. Local and Global Profiles backed up and stored on software's host server such that Profile backup can be applied to a replacement system controller or wired wall station.

7. System supports automated demand response capabilities with automatic reduction of light level to at least three levels of demand response, configurable for each output device.

2.3 SYSTEMS SOFTWARE INTERFACES

A. Management Interface:

1. Web-based management interface for remote system control, live status monitoring, and configuration of lighting control settings and schedules.
2. Compatible with industry-standard web browser clients.
3. Minimum of 100 unique password-protected user accounts.
4. Minimum of three user permission levels: read-only, read and change settings, and full administrative system access.
5. Capable of restricting access for user accounts to specific devices within the system.
6. All system devices capable of being given user-defined names.
7. Device identification information displayed in the Management interface including:
   a. Model number.
   b. Model description.
   c. Serial number or network ID.
   d. Manufacturing date code.

e. Custom label.
f. Parent network device.

8. Management interface capable of displaying live status of a networked luminaire or intelligent control device including:
   a. Luminaire on/off status.
   b. Dim level.
   c. Power consumption.
   d. Device temperature.
   e. PIR occupancy sensor status.
   f. Microphonic occupancy sensor status.
   g. Remaining occupancy time delay.
   h. Photosensor reading.
   i. Active Profiles.
9. Management interface capable of displaying and modifying the current active settings of a networked luminaire or intelligent control device including:
   a. Dimming trim levels.
   b. Occupancy sensor and photosensor enable/disable.
   c. Occupancy sensor time delay and light level settings.
   d. Occupancy sensor response (normal or vacancy).
   e. Photosensor setpoints and transition time delays.
10. Management interface capable of applying settings changes for a zone of devices or a group of selected devices using a single action that does not require the user to apply settings changes for each individual device.
11. Management interface capable of compiling a printable network inventory report.
12. Management interface capable of compiling a printable report detailing all system profiles.
13. All sensitive information stored encrypted.
14. System software updates available for automatic download and installation via the Internet.

B. System Energy Analysis and Reporting:
   1. Intuitive graphical screens to facilitate simple viewing of system energy performance.

2. Energy Scorecard: Summarized display that indicates calculated energy savings in dollars or KWh.
3. Software calculates allocation of energy savings by control measures including occupancy sensors, photosensors, and manual switching.
4. Energy savings data calculated for the system as a whole.
5. Time-scaled graph showing all relay transitions.
6. Time-scaled graph showing zone occupancy time delays.
7. Time-scaled graph showing the total light level.
8. Software capable of storing information remotely onto an open-source, object-relational database, such as PostgreSQL.
9. Data stored in the database will be accessed utilizing an open standard, application programming interface, such as Open Database Connectivity (ODBC).

C. Visualization and Programming Interfaces:
1. System provides an optional web-based visualization interface that displays a graphical floorplan.
2. Graphical floorplan will offer the following types of system visualization:
a. Full Device Option: Master graphic of entire building, by floor, showing each control device installed with zones outlined including:
1) Controls embedded light fixtures.
2) Controls devices not embedded in light fixtures.
3) Daylight sensors.
4) Occupancy sensors.
5) Wall switches and dimmers.
6) Scene controllers.
7) Networked relays.
8) Wired bridges.
9) System Controllers.
10) Wired relay panels.
11) Group outlines.
b. Group-Only Option: Master graphic of the entire building, by floor, showing only control groups outlined.

c. Pan and zoom commands supported to allow smaller areas to be displayed on a larger scale simply by panning and zooming each floor's master graphic.

d. Selecting any control device displays the following as applicable:

1) Device catalog number.

2) Device name and custom label.

3) Device diagnostic information.

4) Link to further information on device including status or current configuration.

3. Programming capabilities through the application will include the following:

a. Switch, occupancy sensor, and photosensor zone configuration.

b. Manual-on or automatic-on modes.

c. Turn-on and dim to dimming levels.

d. Occupancy sensor time delays and PIR sensitivity.

e. Dual technology occupancy sensors sensitivity.

f. Photosensor calibration adjustment and auto-setpoint.

g. Multiple photosensor zone offset.

h. Trim level settings.

i. Preset scene creation and copy for scene-capable devices.

j. Application of custom device labels to the Bluetooth Low-Energy Programming Devices and individual connected lighting control devices.

k. Fade rate settings.

D. Smartphone Programming Interface for Wired Devices:

1. Interface provided for both Apple iOS and Android operating systems that allows configuration of lighting control settings.

2. Application supports configuration or wired networked control devices.

a. Connected device access granted through user-defined passcode at initial install.

b. Indication of signal strength where multiple Bluetooth Low-Energy Programming Devices are available for configuration.

3. Programming Capabilities:

a. Switch, occupancy sensor, and photosensor group configuration.

b. Manual-on or automatic-on modes.

c. Turn-on and dim to dimming levels.

d. Occupancy sensor time delays and PIR sensitivity.

e. Dual technology occupancy sensors sensitivity.

f. Photosensor calibration adjustment and auto-setpoint.

g. Multiple photosensor zone offset.

h. Trim level settings.

i. Preset scene creation.

j. Application of custom device labels for individual connected lighting control devices.

k. Fade rate settings.

2.4 SYSTEM BACKBONE AND SYSTEM INTEGRATION EQUIPMENT

A. System Controller: Multi-tasking, real-time digital control processor consisting of modular hardware with plug-in enclosed processors, communication controllers, and power supplies.

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.
2. System Controller Processor: 32-bit microprocessor operating at a minimum of 1 GHz.
3. System Controller Memory: Minimum of 512MB memory, with a minimum of 4GB non-volatile flash, to support operating system and databases.
4. System Controller Functions:
    a. Time-based control of downstream wired and wireless network devices.
    b. Linking into an Ethernet network.
    c. Integration with Building Management Systems (BMS) and Heating, Ventilation and Air Conditioning (HVAC) equipment.
    d. Connection to various software interfaces, including management interface, historical database and analytics interface, and visualization interface.
5. Integral web server to support system controller configuration and diagnostics with control and visualization of connected devices.
6. Graphical touch screen to support configuration and diagnostics.

7. Minimum of three RJ-45 networked lighting control ports for connection to any of the following:
    a. Graphical touch screen.
    b. Wired communication bridges.
    c. Direct connection to networked wired luminaires and intelligent lighting control devices (up to 128 total devices per port).
8. Device will automatically detect all network-connected devices.
9. Capable of managing and operating a minimum of 750 networked devices (wired or wireless) per system controller.
10. Multiple System Controllers capable of connection via LAN for scalability to a minimum of 20,000 networked devices.
11. Supports BACnet/IP and BACnet MS/TP protocols to directly interface with BMS and HVAC equipment without additional protocol translation gateways.
    a. BACnet MS/TP Connection Speed: 9600 to 115200 baud rate.
    b. BACnet Testing Laboratory (BTL listed) using Device Profile BACnet Building Controller (B-BC) with outlined enhanced features.
12. Integral FIPS 140-2, Level 1 cryptographic module.
13. Supports RESTful API for control of BACnet objects, user management, date and time, and file management.
14. NEMA 1 enclosure with Class 1 and Class 2 separation.
    a. Power Supply Voltage: 120 or 277 V(ac).
15. Automatic algorithm to eliminate redundant, wireless networked paths to streamline communication between the system controller and end devices.
16. System Controller Security Provisions:
    a. Disallow the use of default passwords and require passwords to be updated prior to use.
    b. Support user role-based access, such as administrator, user, and viewer.
    c. Signed firmware to ensure that unmodified, authentic software is always installed.
    d. IP-based communication protected with strong encryption algorithms such as AES or TLS1.2+.

e. Prevent rollback of firmware to firmware versions with known, critical vulnerabilities.

f. Valid cybersecurity listing through a third party.

17. Cellular Remote Access: Cellular router and modem for remote access.

a. Router supports remote access to at least five system controllers on its local area network or network subnet.

b. Remote access capable of device setting updates, schedule updates, system performance optimization, and diagnostics.

c. Remote access enabled through outbound communication from router to an outside source. Solutions that begin communication via inbound requests for network access are unacceptable.

d. Router supports outbound communication to manufacturer-hosted portal using TLS1.2 or greater in-transit encryption over a cellular or Ethernet connection.

e. Router with integral firewall to prevent unauthorized access to devices connected to its local area network port.

f. Router includes cellular SIM capable of connection to AT&T, T-Mobile, Sprint, US Cellular, Alaska Wireless, Telefonica, Tellus, Bell, or Sasktel networks where carrier service is available.

g. Outbound communication from the router limited to whitelisted endpoints. Devices that allow unrestricted communication are unacceptable.

h. Outbound communication from router includes only lighting control system information.

2.5 WIRED NETWORKED DEVICES

A. Wired Networked Wall Switches, Dimmers, Scene Controllers:

1. Basis-of-Design Product: S ubject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; nPODMA, nPODMA xS, nPODMA xP.
2. Mounting: Suitable for installation in single-gang switch box.
3. Communication and low-voltage power delivered via standard low-voltage network cabling with RJ-45 connectors.
4. All switches detect valid communication and blink a unique LED pattern to visually indicate a potential wiring issue.

5. Devices with mechanical push buttons provide tactile and LED user feedback.
6. Devices with mechanical push buttons manufactured with custom button labeling.
7. Wall switch and dimmer options:
    a. Number of control zones: 1.
    b. Control Types Supported:
        1) On/Off.
        2) On/Off/Dimming.
    c. Color: Refer to Division 26, Section 262726 “Wiring Devices”.
8. Scene Controller Options:
    a. Number of Scenes: 4.
    b. Control Types Supported:
        1) On/Off.
        2) On/Off/Dimming.
        3) Preset Level Scene Type.
        4) Reprogramming of other devices within daisy-chained zone to implement user-selected lighting scene including manual start/stop from the scene controller, or optionally programmed automatic stop after a user-selectable duration between five minutes and 12 hours.
        5) Selecting a lighting profile to be run by device's upstream controller to implement a selected lighting profile across multiple zones including manual start/stop from the scene controller, or optionally programmed automatic stop after a user selectable duration between five minutes and 12 hours.
    c. Color: Refer to Division 26, Section 262726 “Wiring Devices”.

B. Networked Graphic Wall Stations:
1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; nPOD TOUCH.
2. Mounting: Suitable for installation in single-gang switch box.
3. Integral 3.5-inch capacitive full-color touch screen.
4. Power via polarity insensitive Class 2 low-voltage 15 to 24V (dc) power supply.
5. Device enables mobile application control of control zones and scenes through Bluetooth.

6. Communication over standard low-voltage network cabling with RJ-45 connectors.
7. User-customizable screen saver utilizing uploaded image file in common file format including jpg, png, gif, bmp, or tif.
8. Capable of configuration of all switches, dimmers, control zones, and lighting preset scenes via password-protected setup screens.
9. Graphic Wall Station Options:
    a. Number of Control Zones: Up to 16.
    b. Number of Scenes: Up to 16.
    c. Profile Scene Duration: User configurable from five minutes to 12 hours.
    d. Color: White.

C. Wired Networked Digital Key Switches:
1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; nPODA KEY MNTN.
2. Mounting: Suitable for installation in single-gang switch box.
3. Communication and low-voltage power delivered via standard low-voltage network cabling with RJ-45 connectors.
4. All switches detect valid communication and blink a unique LED pattern to visually indicate a potential wiring issue.
5. LED user feedback to provide indication of on/off status of the programmed lights or scene, as well as indication of device power.
6. Digital Key Switch Options:
    a. Control Types Supported:
        1) On/Off.
        2) On/Off/Dimming.
        3) Preset Level Scene Type.
        4) On/Off/Dimming/Preset Level for Correlated Color Temperature.
        5) User-programmed local lighting scene run within a daisy-chained group including manual start/stop from the switch, or optionally programmed automatic-stop after a user-selectable duration between five minutes and 12 hours.
        6) User-programmed global lighting profile run by an upstream controller across multiple groups including manual start/stop from the switch, or

optionally programmed automatic-stop after a user-selectable duration between five minutes and 12 hours.

b. Color: Refer to Division 26, Section 262726 “Wiring Devices”.

D. Wired Networked Auxiliary Input / Output (I/O) Devices:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; nIO series.
2. Plenum rated.
3. Mounting: inline wired, screw mountable, extended chase nipple for mounting to a 1/2-inch knockout.
4. Communication and low-voltage power delivered to each device via standard low-voltage network cabling with RJ-45 connectors.
5. Auxiliary Input/Output Devices Options:
   a. Contact closure or pull-high input.
      1) Input programmable to support maintained or momentary inputs that can activate local or global scenes and profiles, activate lights at a preconfigured level, ramp light level up or down, or toggle lights on/off.
   b. 0-10V analog input.
      1) Input supports zero to 10 V dimming output control from a dimmer switch.
      2) Input programmable to function as a daylight sensor.
   c. RS-232/RS-485 digital input.
      1) Input supports activation of up to four local or global scenes and profiles, and on/off/dimming control of up to 16 local control zones.
      2) Provides relay and dimming level status to external device (e.g. Touchscreen) when polled.
   d. 0-10V dimming control output, capable of sinking up to 20mA.
      1) Output programmable to support all standard sequence of operations supported by system.
   e. Digital control output via eldoLED LEDcode communication.
      1) Output programmable to support light intensity control, as well as optional correlated color temperature (CCT) control, of the connected luminaire.

E. Wired Networked Occupancy and Photosensors:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; nCM, nWV.
2. Detect the presence of human activity within space and fully control the on/off function of lights.
3. Utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic and Microwave-based sensing technologies are unacceptable.
4. Dual technology sensors used in locations where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions).
5. Dual technology sensors must have one sensing technology not motion dependent to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT), which detects both occupant motion and sounds indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) are unacceptable.
6. All sensing technologies are acoustically passive, meaning they do not transmit sounds waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers and hearing devices). Acceptable detection technologies include Passive Infrared (PIR), and/or Microphonic technology. Ultrasonic and Microwave-based sensing technologies are unacceptable.
7. Ceiling, fixture, recessed, and corner mounted sensors available, with multiple lens options available customized for specific applications.
8. Communication and low-voltage power delivered to each device via standard low-voltage network cabling with RJ-45 connectors.
9. All sensors detect valid communication and blink a unique LED pattern to visually indicate a potential wiring issue.
10. Sensor programming parameter available and configurable remotely from the software and locally via the device push button.

11. Ceiling mount occupancy sensors include one integrated dry contact switching relay, capable of switching 1 A at 24 V, resistive only.
12. Sensors available with one or two occupancy "poles," each of which provides a programmable time delay.
13. Photosensor/daylight override, automatic dimming control, and low temperature/high humidity operation.
14. Photosensor provide one on/off set-point and include a dead band to prevent the artificial light from cycling. Delay incorporated into the photosensor to prevent rapid response to passing clouds.
15. Photosensor and dimming sensor's set-point and dead band automatically calibrated through the sensor's microprocessor by initiating an "Automatic Set-Point Programming" procedure. Min and max dim settings as well as set-point may be manually entered or modified.
16. Dead band setting verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).
17. Dual zone option available for On/Off Photosensor, Automatic Dimming Control Photosensor, or Combination units. The secondary daylight zone capable of being controlled as an "offset" from the primary zone.

F. Wired Networked Wall Switch Sensors:
1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; nWSXA LV.
2. Mounting: Suitable for installation in single-gang switch box.
3. Communication and low-voltage power delivered via standard low-voltage network cabling with RJ-45 connectors.
4. All switches detect valid communication and blink a unique LED pattern to visually indicate a potential wiring issue.
5. Devices with mechanical push buttons provide tactile and LED user feedback.
6. Wall Switch Sensor Options:
    a. User Input Control Types: On/Off, On/Off/Dimming.
    b. Occupancy Sensing Technology: Dual technology acoustic.
    c. Color: Refer to Division 26, Section 262726 “Wiring Devices”.

G. Wired Networked Power Packs:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; nPP16 series.
   2. Plenum rated.
   3. Communication will be delivered to each device via standard low-voltage network cabling with RJ-45 connectors.
   4. Supply Voltage: 120 to 277 V(ac).
   5. Relay Output: Class 1 relay rated for 16 A at 277 V(ac) and 1/2 HP at 120 V(ac).
   6. Dimming Output: 0-10 VDC Dimming output, Phase-Adaptive (forward and Reverse)
   7. Sink Current: 100 mA at 0-10 V(dc).
   8. Mounting: Integral 1/2-inch chase nipple. Plastic clips into junction box are unacceptable.

H. Wired Networked Communication Bridge:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; nBRG.
   2. Suitable for surface mount to a standard 4 by 4-inch square junction box.
   3. Communication Ports: Eight RJ-45 ports for connection to lighting control zones (up to 128 devices per port), additional network bridges, and System Controller.
   4. Capable of aggregating communication from multiple lighting control zones for purposes of minimizing backbone wiring requirements back to System Controller.
   5. Power Input: Class 2 low-voltage supplied locally via a directly wired power supply.
   6. Wired Bridge capable of redistributing power from its local supply and connected lighting control zones with excess power to lighting control zones with insufficient local power. Architecture enables loss of power to a particular area to be less impactful on network lighting control system.

PART 3 – EXECUTION

3.1 INSTALLATION OF WIRING

A. Wiring Method: Comply with Section 260518 "Wires and Cables." Minimum conduit size is 3/4 inch.
   1. Comply with requirements for raceways and boxes specified in Section 260533.13 "Raceways," and Section 260534 "Boxes".

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.2 IDENTIFICATION

A. Identify system components, wiring, cabling, boxes, cabinets, and terminals. Comply with identification requirements specified in Section 260552 "Electrical Identification."

B. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with Section 260552 "Electrical Identification."

C. Identify all controls with device address.

D. Label each device cable within 6 inch of connection to bus power supply or termination block.

3.3 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Test continuity of each circuit.

B. Field tests and inspections must be witnessed by Electrical Contractor.

C. Tests and Inspections: Engage a factory-authorized service representative to perform test inspections.

1. Test each zone using local and remote control hardware.
2. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.

D. Nonconforming Work:

1. Lighting controls will be considered defective if they do not pass tests and inspections.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

E. Field Test Reports: Engage a factory-authorized service representative to prepare field test reports.

1. Prepare functionality and inspection reports, including a certified report that identifies controls included and describes test results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

2. Include list of all points created from actual tests of all addressed control points for lamps, ballasts, manual controls, and sensors.

3.4 REMOTE ACCESS

A. Digital network lighting control system capable of remote access by manufacturer with the following features:
   1. System diagnostics including detection of fault condition in hardware or connected devices.
   2. Access to all connected devices for complete programming including scheduling of time-of-day events and device parameters necessary to meet required sequence of operations.
   3. Browser-based interface to verify system functionality.
   4. On-demand access to manufacturer technical support for remote troubleshooting, diagnostics, configuration, and programming.
   5. Owner training on the digital network lighting control system available remotely.

B. Remote access system fully functional over commercial celluar connection or Internet-connected ethernet network.

C. All hardware associated with remote access including cellular modem and cellular antenna are to remain on-site regardless of warranty or cellular contract status.

3.5 SYSTEM STARTUP

A. Factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks in accordance with manufacturer's published instructions.
   2. Activate luminaires and verify that all maximum output levels match output levels detailed in an Owner-approved sequence of operations.
   3. Confirm correct communications wiring, initiate communications between control devices and controller/gateways, and program the lighting control system in accordance with approved configuration schedules, time-of-day schedules, and input override assignments.
   4. Program network devices to meet required sequence of operations.
   5. Program and verify all sequence of operations.
   6. Create backup of system programming.

7. Assist in installation of system software on customer-provided workstation or server.
8. Verify bidirectional communication of manufacturer-provided cellular router with manufacturer-managed remote access portal.

B. Commissioning Walkthrough: Engage a factory-authorized service representative to collaborate with third-party commissioning agent to demonstrate lighting control system functionality and verify the system meets the specified Project requirements.

3.6 CLOSEOUT ACTIVITIES

A. Enhanced Documentation: Engage lighting system manufacturer to provide comprehensive system documentation including detailed programming, sequence of operation data per Project specifications, and related code requirements.

B. Training: Engage lighting system manufacturer to provide comprehensive system overview, software overview, and documentation relating to system operation and maintenance.

3.7 PROTECTION

A. After installation, protect digital network lighting controls from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.8 MAINTENANCE

A. Engage a factory-authorized service representative to perform on-site system adjustments.
1. On-Site Occupancy Adjustments: When requested within 3 months from date of Substantial Completion, provide on-site settings adjustments to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
2. Prepare and submit report after each visit that details activities performed.

B. Maintenance Service Agreement:
1. Beginning at Substantial Completion, verify that maintenance service agreement includes 12 months' full maintenance by manufacturer's authorized service representative.
2. Include semiannual on-site and remote preventive maintenance.

3. Preventative maintenance to include:
    a. System diagnostic reports.
    b. System performance checks.
    c. Device firmware updates.
    d. Programming adjustment as required for proper lighting system operation.
    e. Expedited factory direct warranty processing, replacement, and programming of defective components.
4. Verify that parts and supplies are manufacturer's authorized replacement parts and supplies.

END OF SECTION 260943.13

SECTION 262416 – PANELBOARDS

PART 1 – GENERAL

1.1 NOTE

A. The general provisions of the Contract including Uniform General Conditions and Supplementary General Conditions, Special Conditions and General Requirements (Division 01), apply to the work specified in this section.

1.2 SUBMITTALS

A. Submit the following information for review:

1. Complete drawings showing dimensions.
2. Conduit entry/exit locations.
3. Voltage rating, continuous current rating, and short-circuit rating.
4. Cable terminal sizes.
5. Catalog product sheets.
6. Nameplate Identification.

1.3 SCOPE

A. Provide, install, and connect all electrical panelboards shown on the drawings and specified herein. Panels shall be complete assemblies including enclosures, bussing, overcurrent protective devices, and trim.

1.4 QUALITY ASSURANCE

A. Referenced Standards. Provide products that comply with the referenced standards. These Standards are incorporated into this Specification by reference.

1. National Fire Protection Association (NFPA)
   - No. 70 National Electrical Code (NEC)
2. Underwriters Laboratories, Inc. (UL)
   - UL 50 Cabinets and Boxes
   - UL 67 Panelboards
   - UL 489 Molded Case Breakers / Enclosures
3. National Electrical Manufacturers Association (NEMA)
   - PB-1 Panelboards
   - No. 250 Enclosures for Electrical Equipment

AB-1 Molded Case Circuit Breakers

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to project requirements, products manufactured by (but not limited to) the following companies are acceptable:

1. Square D
2. Eaton
3. ABB

2.2 PANELBOARD REQUIREMENTS

A. All panelboards shall be listed by Underwriters Laboratories.

B. The building main panel shall be listed as suitable for “Service Entrance Equipment”.

C. Panels shall be arranged for flush mounting, surface mounting, or free-standing as indicated on the drawings.

D. Panels shall have the voltage ratings, continuous current ratings, and interrupting ratings as scheduled on the drawings.

E. All panelboard accessories and features scheduled or specified on the drawings shall be provided.

F. Where a circuit protective device is scheduled as a “spare”, provide the device complete for operation. Where the device is scheduled as a “space” or “space only”, provide proper space and all necessary connectors for future installation of the size of device scheduled. Where the device is scheduled to serve a “future” load, provide the device complete for operation.

G. All circuit breakers shall be quick make, quick break, trip-free, thermal magnetic indicating type unless otherwise noted.

H. Branch circuit breakers shall be fully interchangeable without disturbing adjacent units.

I. Connect all overcurrent protective devices with sequence phasing.

J. Provide each panelboard with a neatly typewritten directory of circuits mounted in a plastic covered cardholder on the inside of the panelboard door.

K. Install laminated plastic nameplate for each panel as specified under ELECTRICAL IDENTIFICATION Section.

2.3 CONSTRUCTION

A. Cabinets:

1. Rigidly constructed of galvanized sheet steel per UL 50 Standards. Corners shall be overlapped or welded with the edges turned over to receive trim.
2. Where two-section panels are required, both sections shall be same height, and have fully rated bussing in separate cabinets connected by conduit nipples.

B. Trim:

1. Fabricated from sheet steel meeting the requirements of UL 50 Standards. Trim shall have medium gray enamel finish suitable to serve as the final finish, or suitable to receive field painting.
2. Trim door shall have rounded corners and edges free from burrs.
3. Surface trims shall be the same height and width as box. Flush trims shall overlap the box ¾" on all sides.
4. Furnish each door with substantial flush, cylinder tumbler lock and catch. Doors more than 48" high shall have auxiliary fasteners. Provide each lock with 2 keys. All locks shall be keyed alike.
5. Unless noted otherwise, interior mounted panels shall have type 1 fronts (one piece with hinged door). Where door-in-door construction is specified, it shall consist of a hinged door within a piano-hinged cover secured with trim clamps.
6. Exterior mounted panels shall be type 3R in accordance with UL 50 requirements. All doors shall be gasketed and be equipped with a tumbler type vault lock and two additional trunk type latches.

C. Bussing:

1. All bussing shall be plated copper sized in accordance with UL Standards to limit temperature rise on any current-carrying part to a maximum of 65 degrees C above an ambient of 40 degrees C maximum.
2. Main lugs and main breakers shall be UL approved for copper or aluminum conductors sized to accommodate the conductors to be terminated. Provide oversized lugs to terminate conductors that are increased in size due to voltage drop or temperature requirements.
3. A bolted ground bus shall be included in all panels. Where scheduled, an isolated ground bus shall also be included.

4. A full size (100%) neutral bar shall be furnished for panels shown with neutral. Neutrals shall have suitable lugs for each outgoing feeder requiring neutral connection. Where scheduled, provide 200% rated neutrals with lugs for oversized neutral conductors.

2.4 LIGHTING AND APPLIANCE PANELS

A. Bolt-in type, heavy duty, quick-make, quick-break, single- and multi-pole molded case circuit breakers with toggle handles that indicate when unit has tripped.

B. Circuit breakers shall be thermal magnetic type with common handle for all multiple pole breakers.

C. Breakers shall be UL listed as type SWD for lighting circuits.

D. Circuit breaker handle locks shall be provided for all circuits that supply exit signs, emergency lights and fire alarm panels.

E. Breakers shall be fully rated to interrupt the fault current values scheduled on the drawings.

F. Provide breaker accessories as scheduled on the drawings.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install panelboards in accordance with manufacturers written instructions, NEMA PB1.1 and NEC standards.

B. Panelboard enclosures shall be securely fastened to the structure with a minimum of four bolts or screws.

C. Clean dirt and foreign paint from exterior and interior of all panels.

D. Do not splice conductors in panels.

E. Conductors not terminating in panelboard shall not extend through or enter panel enclosure.

F. A single conductor shall terminate in each lug on a circuit breaker. Do not terminate multiple conductors under a single lug.

G. During installation carefully balance the electrical loads between the various phases. This may require connecting loads to circuits different from the circuit numbers indicated on the drawings.

3.2 IDENTIFICATION

A. Identify and color-code conductors in panelboards as specified under WIRES AND CABLES Section.

B. Install panelboard nameplate identification as specified under ELECTRICAL IDENTIFICATION Section.

C. Provide individual circuit identification for each circuit with a type-written directory of circuits mounted in a holder on the inside of the panel door. The directory shall identify the type or name of the load served along with the room names and numbers. The room names and numbers shall be the final names and numbers assigned to the space and not those used on the drawings.

3.3 FIELD QUALITY CONTROL

A. Inspection:

1. Visually inspect each panel for proper grounding connections as specified under GROUNDING AND BONDING Section.
2. Visually inspect breakers and switches for broken parts and loose terminals.
3. Visually verify proper color-coding of conductors as specified under WIRES AND CABLES Section.
4. Visually verify panelboard trim fits properly with no gaps between the trim and panel enclosure.

B. Testing:

1. Test cable mechanical connections to the manufacturers recommended values with calibrated torque wrench.
2. Operate each breaker ON and OFF to verify proper operation.
3. Energize circuits and demonstrate proper operation.
4. When the facility is under normal use, amperage measurements shall be taken on each phase conductor in each panel feeder, and any unbalances shall be corrected to a point that no conductor load shall be more than 5% high or low (maximum unbalance of 10%).

END OF SECTION 262416

SECTION 262726 – WIRING DEVICES

PART 1 – GENERAL

1.1 NOTE

A. The general provisions of the Contract including Uniform General Conditions and Supplementary General Conditions, Special Conditions and General Requirements (Division 01), apply to the work specified in this section.

1.2 SUBMITTALS

A. Submit product data sheets for all wiring devices.

1.3 SCOPE

A. Furnish and install in suitable outlet boxes, the wiring devices indicated complete with coverplates. All shall be properly connected to conductors so as to be operable.

1.4 QUALITY ASSURANCE

A. Referenced Standards: Provide products that comply with the referenced standards. These Standards are incorporated into this Specification by reference.

1. National Fire Protection Association (NFPA)
   - No. 70 National Electrical Code (NEC)
2. National Electrical Manufacturers Association (NEMA)
   - WD 1 General Requirements for Wiring Devices
   - WD 6 Wiring Devices – Dimensional requirements
3. Underwriters Laboratories (UL)
   - UL 20 General-Use Snap Switches

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to project requirements, products manufactured by (but not limited to) the following companies are acceptable:

1. Hubbell
2. Leviton
3. Pass & Seymour
4. Bryant

2.2 CLASSIFICATION

A. All wiring devices shall be UL listed.

B. All wiring devices shall be specification grade.

2.3 COLORS

A. All devices shall have **white** finish where mounted in walls finished in light colors and a brown finish where mounted in walls finished in dark colors.

2.4 SWITCHES

A. Refer to Section 260943.13, DIGITAL-NETWORK LIGHTING CONTROLS.

2.5 RECEPTACLES

A. The catalog numbers listed are of Hubbell manufacture. Equivalent devices from listed manufacturers are acceptable. Furnish receptacles in colors specified even though the numbers listed may not contain the correct suffix.

1. Duplex receptacle: 20 amp, 125 volt, grounding (NEMA 5-20R) – No. 5362.
2. Ground Fault Interrupter Receptacle (GFI) – No. GF-5362.
3. Special Receptacles: Furnish devices in the NEMA configuration listed on the drawings.

2.6 WEATHERPROOF DEVICES

A. Provide the specified device in weatherproof cast box with gasketed coverplate.

2.7 COVERPLATES

A. Provide coverplates for all wiring devices, including telephone, signal outlets and other devices. Coverplates shall be one piece single or multi-gang type as required.

B. Indoor Flush Devices:

1. Type 302 stainless steel.
2. Where installed in masonry walls, use jumbo plates.

C. Indoor Surface Devices: For indoor devices use zinc-coated metal with rounded or beveled edges, same size as the box.

D. Outdoor devices: TayMac

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install wiring devices plumb and level.

B. Install SPST wall switches with OFF position down.

C. Wall switches shall be installed on the strike side of the door as finally hung.

D. Install receptacles with grounding pole on top.

E. Install devices within outlet boxes to allow coverplates to be in full contact with the wall on all sides.

F. After connection of each wiring device, install two full wraps of electrical insulating tape around the side terminals prior to installation in the box.

G. Replace broken devices and plates with new.

H. Clean all paint, plaster and dirt from wiring devices and plates.

3.2 MOUNTING HEIGHTS

A. Where mounting heights are indicated on the drawings, the device shall be installed with the centerline of the device at the indicated height.

B. Devices noted to be installed above counters or millwork shall be installed above the backsplash.

C. Unless otherwise noted on the drawings, or directed by architect, install devices at the following heights above finished floor:

DEVICE	MOUNTING HEIGHT
Wall switch	46”
Receptacle	18”
Wall dimmer switch	46”
Telephone outlet	18”
Data Outlet	18”

3.3 IDENTIFICATION

A. At each wiring device mark the inside of the coverplate with the panel and circuit number to which the device is finally connected. Use black indelible marker.

3.4 FIELD TESTING

A. Energize lighting circuits and operate each wall switch to verify proper operation.

B. Energize receptacle circuits and test each receptacle with circuit tester to verify the device is energized and has correct polarity.

C. Test TRIP and RESET buttons on GFI receptacles. In addition, test GFI receptacles with a GFI tester to verify it trips at 4ma of ground current.

END OF SECTION 262726

SECTION 262815 – SAFETY SWITCHES

PART 1 – GENERAL

1.1 NOTE

A. The general provisions of the Contract including Uniform General Conditions and Supplementary General Conditions, Special Conditions and General Requirements (Division 01), apply to the work specified in this section.

1.2 SUBMITTALS

A. Submit the following information for review:

1. Complete drawings showing dimensions.
2. Conduit entry/exit locations.
3. Voltage rating, continuous current rating, and short-circuit rating.
4. Cable terminal size.
5. Fuse rating and type.

1.3 SCOPE

A. Provide, install, and connect all safety switches shown on the drawings or required by codes.

1.4 QUALITY ASSURANCE

A. Referenced Standards. Provide products that comply with the referenced standards. These Standards are incorporated into this Specification by reference.

1. National Fire Protection Association (NFPA)
   - No. 70 National Electrical Code (NEC)
2. Underwriters Laboratories, Inc. (UL)
   - UL 50 Enclosures for electrical Equipment
   - UL 98 Enclosed and Dead-Front Switches
3. National Electrical Manufacturers Association (NEMA)
   - No. 250 Enclosures for Electrical Equipment

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to project requirements, products manufactured by (but not limited to) the following companies are acceptable:

1. Square D
2. Eaton
3. ABB

2.2 HEAVY DUTY SWITCHES

A. Requirements: Provide and install safety switches as shown on the drawings or as required by NEC. Where code requires the installation of safety switches that are not shown on the drawings, provide and install the required switches.

B. All switches shall be heavy-duty type.

C. Switches shall be fusible or non-fusible as noted on the drawings or as required by codes.

D. Provide switches with the voltage and current ratings as shown on the drawings.

E. Where safety switches serve as motor or motor starter disconnects, provide horsepower rated switches with auxiliary contacts to disconnect all power and control circuits.

F. Construction:

1. Switch blades and jaws shall be plated copper.
2. Switches shall have a handle that is easily padlockable in the OFF position.
3. Switches shall have defeatable door interlocks that prevent the door from opening when the handle is in the ON position.
4. Switch assembly and operating handle shall be an integral part of the enclosure base.
5. Switches rated 100A to 600A shall have reinforced fuse clips.
6. Switch blades shall be readily visible in the OFF position.
7. Switch operating mechanism shall be non-teasible, positive quick-make / quick-break type.
8. Fusible switches shall be suitable for service entrance equipment.
9. Switches shall have line terminal shields.
10. Switches shall have CU/AL mechanical lugs.

G. Enclosures:

1. Where installed indoors, all enclosures shall be NEMA I, general purpose type unless otherwise noted.
2. Where installed outdoors, all enclosures shall be NEMA 3R, raintight type unless otherwise noted.

3. Where noted on the drawings, provide the following enclosures:
    a. NEMA 4 – watertight (304 stainless steel).
    b. NEMA 12 – dust tight/oil tight.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install safety switches in accordance with manufacturers written instructions and NEC requirements.

B. Install adjacent disconnects at the same height.

C. Install disconnects to maintain the required NEC clearances and working space.

3.2 IDENTIFICATION

A. Identify and color-code conductors in safety switches as specified under WIRES AND CABLES Section.

B. Install engraved plastic sign on each safety switch as specified in ELECTRICAL IDENTIFICATION Section.

C. The sign shall contain 3 lines of text. The top line shall identify the load served. The center line shall indicate the voltage. The third line shall indicate the source of supply.

D. An example of the required identification is:

AHU #2

480 V

Fed From Panel PP

3.3 FIELD QUALITY CONTROL

A. Inspection:

1. Visually inspect each switch for proper grounding connections as specified under GROUNDING AND BONDING Section.
2. Visually verify proper color-coding of conductors in safety switches as specified under WIRES AND CABLES Section.
3. Verify fusible switches contain proper type and size of fuses.

B. Testing:

1. Test cable mechanical connections to the manufacturers recommended values with calibrated torque wrench.
2. Operate each switch ON and OFF four times to verify proper operation.

3. Energize circuit and verify proper operation.

END OF SECTION 262815

SECTION 264600 - DRY-TYPE TRANSFORMERS

PART 1 - GENERAL

1.1 NOTE

A. The general provisions of the Contract including Uniform General Conditions and Supplementary General Conditions, Special Conditions and General Requirements (Division 1), apply to the work specified in this section.

1.2 SUBMITTALS

A. Submit the following information for review:

1. Drawing showing dimensions, wiring diagram and weight.
2. Transformers ratings:
    a. KVA
    b. Primary and secondary voltages.
    c. Primary and secondary continuous currents.
    d. Taps
    e. Impedance
    f. Insulation class and temperature rise.
    g. Sound Level
3. Certification that the transformers are constructed and tested in accordance with the referenced Standards.

1.3 SCOPE

A. Furnish, install, and connect all dry-type transformers shown on the drawings. The transformers covered by this Section are those having primary and secondary voltages of 600 volts or less.

1.4 QUALITY ASSURANCE

A. Referenced Standards: Provide products that comply with the referenced standards. These Standards are incorporated into this Specification by reference.

1. National Fire Protection Association (NFPA)
    No. 70 National Electrical Code (NEC)
2. American National Standards Institute (ANSI)
    C57.12.50 Ventilated Dry-type Distribution Transformers
    C57.12.51 Ventilated Dry-type Power Transformers

3. National Electrical Manufacturers Association (NEMA)

   ST 20 Dry-type transformers for General Applications

4. Underwriters Laboratories (UL)

   No. 506 Specialty Transformers

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to project requirements, products manufactured by (but not limited to) the following companies are acceptable:

1. Square D
2. Eaton
3. ABB

2.2 GENERAL REQUIREMENTS

A. All transformers shall be UL listed and bear the UL label.

B. Transformers shall be two-winding, self-cooled type.

C. Transformers shall be designed for continuous operation at rated KVA, for 24 hours a day, 365 days a year operation, with normal life expectancy as defined by ANSI C57.96.

2.3 CONSTRUCTION

A. Insulation Systems:

1. 3 – 15 KVA: 185 degree C insulation system based upon 115 degree C rise in 40 degree C maximum ambient.
2. 15 KVA and above: 220 degree C insulation system based on 80 degree C rise in 40 degree C maximum ambient.

B. Core and Coil Assemblies:

1. Transformer core shall be constructed with high-grade, grain-oriented silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Maximum magnetic flux densities shall be substantially below the saturation point. Core laminations shall be tightly clamped and compressed. Coils shall be wound of electrical grade aluminum with continuous wound construction.
2. On units rated 9 KVA and below the core and coil assembly shall be completely encapsulated to provide a moistureproof and shock resistant shield. Taps shall be two (2) steps below nominal voltage in 5% increments.

3. On units rated 15 KVA and above the core and coil assembly shall be impregnated with non-hydroscopic, thermosetting varnish and cured to reduce hot spots and seal out moisture. The assembly shall be installed on vibration-absorbing pads. Taps shall be two (2) steps above and four (4) steps below nominal voltage in 2.5% increments.
4. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor.

C. Electrostatic Shielding:
1. Where noted on the drawings provide isolation transformers with electrostatic shielding.
2. An electrostatic shield consisting of a single turn of aluminum shall be placed between the primary and secondary winding, and grounded.

D. Enclosure:
1. Enclosures shall be made of heavy-gauge sheet steel. Transformers shall be equipped with a wiring compartment suitable for conduit entry and large enough to allow convenient wiring.
2. On units rated 9 KVA and below (encapsulated), the enclosure construction shall be totally enclosed non-ventilated, NEMA 3R, with lifting eyes.
3. On units rated 15 KVA and above, the enclosure construction shall be ventilated, drip-proof with lifting holes. The ventilation openings shall be protected against falling debris. Where installed outdoors, provide weather shields over the ventilation openings.
4. Enclosures shall be finished in medium gray, weather-resistant enamel.

E. Sound Levels: Transformer sound ratings shall not exceed the following levels for self-cooled ratings:

KVA Rating	Sound Level
9 KVA and below	40 dB
10 – 50 KVA	45 dB
51 – 150 KVA	50 dB
151 – 300 KVA	55 dB
301 – 500 KVA	60 dB
501 – 700 KVA	62 dB
701 – 1000 KVA	64 dB

PART 3 - EXECUTION

3.1 INSTALLATION

A. Dry-type transformers larger than 15 KVA shall be floor mounted, unless wall or suspension mounting is indicated on the drawings. Transformers 15 KVA and smaller shall be wall mounted.

B. Floor mounted transformers shall be mounted on neoprene pads 5/8” thick for vibration and noise control. Wall mounted transformers shall have vibration and noise eliminator pads installed between the mounting brackets and wall.

C. Where transformers are indicated to be suspended, construct a mounting platform of welded or bolted angle iron. Support the platform from building construction with steel rod hangers, with spring type vibration and noise eliminators interposed between the rods and platform. All vibration isolators shall be properly selected by their manufacturer for the specific duty involved.

D. Install all conductors to and from each transformer in flexible metallic conduit not less than 24 inches long.

E. Install transformers in accordance with the manufacturers written instructions. Unless otherwise directed, install transformers with a minimum of 12 inches clear on all sides for ventilation.

F. Ground the secondary neutral of dry-type transformers as specified under GROUNDING AND BONDING Section.

G. Adjust the tap settings to deliver nominal rated voltage.

3.2 IDENTIFICATION

A. Install engraved plastic sign for each transformer as specified in ELECTRICAL IDENTIFICATION Section.

B. The sign shall contain 3 lines of text. The top line shall the transformer name. The center line shall indicate the source of supply, and the bottom line shall indicate the panel served.

C. An example of the required identification is:

Transformer T1
Fed from Panel HDP
Serves Panel LDP

3.3 FACTORY TESTING

A. The following standard factory tests shall be performed. All tests shall be in accordance with ANSI and NEMA Standards.

1. Ratio tests at rated voltage connection and at all tap connections.
2. Polarity and phase relation tests on the rated voltage connection.
3. Applied potential tests.
4. Induced potential test.
5. No-load and excitation current at rated voltage on the rated voltage connection.

3.4 FIELD QUALITY CONTROL

A. Inspection:

1. Visually inspect each transformer for proper grounding connections as specified under GROUNDING AND BONDING Section
2. Visually verify proper color-coding of conductors at each transformer as specified under WIRES AND CABLES Section.
3. Visually verify proper clearance and ventilation space around each transformer.

B. Testing:

1. Test cable connections to the manufacturers recommended values with calibrated torque wrench.
2. Measure primary and secondary voltages for proper tap settings. Record voltage readings and tap setting.
3. Megger primary and secondary windings.

END OF SECTION 264600

SECTION 265100 – LIGHTING

PART 1 – GENERAL

1.1 NOTE

A. The general provisions of the Contract including Uniform General Conditions and Supplementary General Conditions, Special Conditions and General Requirements (Division 01), apply to the work specified in this section.

1.2 SUBMITTALS

A. Submit product data sheets for all lighting products.

B. Submit complete photometric data for each fixture.

1.3 SCOPE

A. This Section pertains to all labor, material, equipment and services necessary for and incidental to the complete interior and exterior lighting system as shown on the drawings and specified herein.

1.4 QUALITY ASSURANCE

A. Referenced Standards: Provide products that comply with the referenced standards. These Standards are incorporated into this Specification by reference.

1. National Fire Protection Association (NFPA)
   - No. 70 National Electrical Code (NEC)
   - No. 101 Life Safety Code
2. National Electrical Manufacturers Association (NEMA)
   - LE 4 Recessed Luminaires, Ceiling Compatibility
3. Underwriters Laboratories (UL)
   - UL 924 Emergency Lighting and Power Equipment
   - UL 1449 Surge Protection Devices
   - UL 8750 Light Emitting Diode (LED) Equipment for Use in Lighting Products
4. Illuminating Engineering Society (IES)
   - LM-79 Electrical and Photometric Measurements of Solid-State Lighting Products
   - LM-80 Measuring Lumen Maintenance of LED Light Sources
   - TM-21 Projecting Long Term Lumen Maintenance of LED Light Sources

PART 2 – PRODUCTS

2.1 LUMINAIRES

A. Provide and install a lighting fixture on each lighting outlet shown. Furnish fixtures in accordance with the designations scheduled on the drawings. Should any designation be omitted on the drawings, furnish fixtures of the same type as used in rooms of similar usage. All features scheduled for fixtures shall be provided, even if the catalog number given in the schedule lacks the required numerals, prefixes of suffixes corresponding to the feature called for.

2.2 LED FIXTURES

A. Fixtures shall bear UL label.

B. General Requirements:

1. Drivers shall be Electronic type.
2. Total Harmonic Distortion Rating: 20% or less
3. Power Factor: 90% minimum.
4. Sound Rating: A
5. Surge Protection: Surge protection devices (SPD) to be provided with each luminaire.
6. RF Interference: Labeled as compliant with radio frequency interference (RFI) requirements of FCC Title 47 Part 15.

2.3 LAMPS

A. LEDs:

1. Color Temperature: As scheduled on the drawings.
2. CRI: 80 or higher.
3. Lumen output as scheduled on the drawings.
4. LEDs of the same fixture type shall be supplied from the same batch during manufacturing.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Installation of Interior Fixtures: Outlet box locations shown for LED fixtures are diagrammatic. Locate boxes to coincide with stem hangers where such occur. Fixtures shall be level, square with the general construction and securely attached.

B. Lay-in Type Fixtures: Refer to the ceiling installer's layout for exact location. Center the fixtures in ceiling grids. Wire the fixtures using concealed outlet boxes accessible through ceiling panels. Install conductors in flexible metallic conduit from box to fixture.

C. Fixtures in Plaster Ceilings: Provide a suitable plaster ring or frame for each fixture recessed in a plaster ceiling.

D. Surface Mounted Fixtures: Fixtures shall be installed flush with the ceilings. Where fixtures are mounted to an exposed grid ceiling, the fixtures may be clipped to the ceiling grid provided the attachment holds the fixture flush, level, and secure. Where they cannot be centered on a grid, install a structural member to span two tees and attach the fixture to the structural members.

E. Where fixtures are installed in a continuous row, the row shall be straight and plumb. Lens shall be aligned in all planes and no part of the lamp shall be visible.

END OF SECTION 265100

SECTION 283300 – FIRE ALARM AND DETECTION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, Uniform General Conditions, Supplementary Conditions and Division 1 - General Requirements apply to Work of this Section.

1.2 SUBMITTALS

A. The installing contractor and/or equipment manufacturer shall provide complete and detailed shop drawings and include:

1. Point to point wiring diagram showing terminal connections to all system devices. This would include the size of conductors to each device and proposed routing. After review, this shall become the installation drawing.
2. Riser wiring diagram and conduit sizes.
3. Floor plan drawings locating all devices associated with the Fire Alarm System.
4. Factory data sheets on each piece of equipment to be used and so marked as to dimensions, size, voltage, style, catalog number, manufacturer's names, and configuration.
5. Detailed system description and operation describing system functions.
6. Complete Bill of Material for reference.
7. Calculations for power supply, voltage drop and battery size.

B. All submittal data shall be in bound form with contractor's name, supplier's name, project name, and state fire alarm license number adequately identified.

1.3 QUALIFICATIONS

A. The installing contractor shall be the authorized representative of the fire alarm manufacturer to sell, install and service the manufacturer's equipment.

B. The installing contractor must be licensed by the state Fire Marshall to sell, install and service fire alarm systems.

C. The installing contractor shall have on their staff an installation superintendent who is licensed by the State Fire Marshall's office for such purpose and under whose supervision installation shall take place, as required by the Texas Insurance Code.

D. The fire alarm installation firm will have factory trained personnel performing the control panel wiring for the system that they were trained for. The firm shall also maintain a stock of parts and components used in the system.

E. The qualifications of the installation firm, the availability of replacement parts and service records will be considered.

1.4 CLOSE-OUT MANUALS

A. Provide three sets of operation and maintenance manuals which includes:

1. Complete typewritten operating instructions.
2. A parts list for the system identifying the components with ordering numbers.
3. A plan showing conduit size, number and size of conductors and locations of all devices.

1.5 CODES AND STANDARDS

A. The installation and testing shall be made under the provisions of the latest National Electrical Code (NFPA-70); NFPA 101 (Life Safety Code). NFPA 71, NFPA 72, UL Standards (1480, 864, 268, 268A, 217, 521, 228, 464, 1638, 38, 346, 1481), and all other applicable state and local codes and ordinances. The Contractor shall submit the new fire alarm equipment layout to the local fire alarm authority having jurisdiction for approval.

1.6 SCOPE

A. The Contractor shall modify the existing 24 VDC, fire detection and alarm system as specified herein and indicated on the drawings. It is the intent to obtain a complete system which shall operate as described herein, and all equipment necessary for such operation shall be provided whether or not each item is enumerated herein or described on the drawings. The system shall include, but not be limited to, all control panels, power supplies, alarm initiating devices, audible and visual alarm devices, conduit, wire, fittings and all other accessories required to provide a complete and operable system. The system shall operate as a continuous sounding system which shall have multiple audible alarm circuits. The system signaling line circuits shall be wired as Class B (to match existing) circuits. The system notification appliance circuits shall be wired as (Class B) supervised circuits.

1.7 QUALITY

A. All equipment, materials, accessories, devices, and other facilities covered by this specification or noted on contract drawings and installation specifications shall be of the best suited for the intended use and shall be provided by a single manufacturer or, if provided by different manufacturers, recognized as compatible by both manufacturers.

B. All equipment and material shall be new and unused, unless directed otherwise.

C. Wiring: All wiring shall be in accordance with the National Electric Code, local codes and the National Fire Protection Association-70, Article 760. The minimum wire sizes shall be 12 gauge for AC power supply connections and auxiliary circuits, 14 gauge for DC power supply connections, 16 gauge for audible alarm circuits. Cable for SLC loops shall be 18 to 12 AWG twisted pair with a shield jacket. Shield continuity must be maintained. Intelligent detector wiring must not be routed adjacent to, or in the same conduit with Audio/Visual power wiring, 120/240 VAC power wiring or other high current circuits.

D. Wire shall be UL listed for limited energy (300V), plenum rated, and approved for fire alarm applications and shall be installed in a minimum of ¾" conduit when run in walls.

1.8 TESTING, GUARANTEE, SERVICE

A. A factory trained technical representative of the manufacturer shall perform the final connections, complete system checkout and testing of the system, and it shall be subject to the final acceptance and approval of the engineer and local authorities. Upon completion and acceptance, the owner and/or his representative(s) shall be instructed in the proper use of the system. A written copy of the final system test and checkout shall be provided detailing the function of each device. Furnish the Owner, Architect, Engineer and all authorities having jurisdiction a Certificate of Compliance.

B. All equipment and wiring shall be free from defects in workmanship and materials, under normal use and service, for a period of one year from owner acceptance or beneficial occupancy, whichever comes first. Any equipment shown to be defective shall be replaced, repaired, or adjusted free of charge.

C. The manufacturer shall be represented by a local service organization and the name of such supplied to the Owner and Engineer.

1.9 COORDINATION

A. It shall be the responsibility of the installing contractor to coordinate all requirements surrounding installation of the Fire Alarm System with all trades including, but, not

exclusive of: electrical contractor, HVAC contractor, sprinkler contractor, elevator contractor, and HVAC controls contractor. Adequate coordination shall be provided to insure proper installation and interface to all peripheral items required to interact with the Fire Alarm System to provide a complete and functional system.

PART 2 - PRODUCTS

2.1 DESCRIPTION OF SYSTEM

A. The Fire Alarm and Detection System shall be a single integrated system by a single manufacturer. The Contractor shall assume sole responsibility for its operation. The fire detection portion of the system shall consist of the existing fire alarm panel and shall contain all additional power supplies, relays, modules and batteries as required for the operation described herein.

2.2 DESCRIPTION OF OPERATION

A. Operation of manual or automatic initiating device shall cause the following events to occur:

1. The System alarm LED shall flash.
2. A local sounding device in the panel shall be activated.
3. The display and remote annunciators shall indicate all pertinent information associated with the alarm and its location.
4. All automatic programs assigned to the alarm point shall be executed and the associated indicating devices and relays activated, such as:
    a. The appropriate indication shall appear on the fire control panel.
    b. A message shall sound on all alarm speakers and all visual strobes and exit signs shall flash.
    c. Remote Point Annunciation devices shall show an alarm condition if devices connected to it are in alarm condition.
    d. All required smoke dampers shall close.

2.3 CONTROL PANEL

A. The control panel is existing and shall be reused.

2.4 PHOTOELECTRIC SMOKE DETECTORS AND DUCT DETECTORS

A. The Photoelectric Smoke Detectors and duct detectors shall match existing.

2.5 INDICATING DEVICES

A. The alarm indicating devices shall be UL listed. All strobes shall be synchronized when in view of each other. Indicating devices shall match existing.

2.6 REMOTE FIELD POWER SUPPLY

A. Provide new remote field power supply Honeywell HPFPS10 and batteries BAT-1270-BP (12V7A) to match existing.

2.7 MANUAL FIRE ALARM PULL STATIONS

A. Provide new pull station to match existing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The installation of the system shall be made by the Contractor under the supervision of a representative of the manufacturer who shall make the final connection to the system, perform the functional tests of the system and place it in operation.

B. Installation shall be in strict compliance with manufacturer's recommendations. Consult manufacturer for all wiring diagrams, schematics, sizes, outlets, etc. before installing conduits and pulling wires.

C. Fire alarm devices shall be mounted upon and all splices made in Listed Boxes. Wiring splices are to be avoided to the extent possible and Transposing or changing colors will not be permitted".

D. As indicated on the drawings, each zone shall be labeled on the Fire Alarm Control Panel. Names of the zones shall be coordinated with the Owner, and shall meet with the Owner's approval.

E. Heat and Smoke Detectors: The location of detectors shown on the plans is schematic only. The detector must be located according to code requirements.

F. Smoke detectors should be installed to favor the air flow towards return openings and not located where air supply diffusers can dilute smoke before it reaches the detector.

G. Mount pull stations at 4'AFF and indicating devices at 80"AFF.

H. Label all fire alarm junction boxes F/A.

3.2 FINAL INSPECTION

A. After the system has been placed in service and all items are functioning properly, call for a final inspection. The manufacturer's representative shall be present and shall demonstrate the operation of the system to the satisfaction of the Owner.

3.3 INSTRUCTION

A. The representative of the manufacturer shall allot eight (8) hours to instruct the Owner's personnel as to the complete operation of the system.

END OF SECTION 283300