Delaware Technical & Community College

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ALLIED HEALTH - C WING ADDITION & RENO

PROJECT MANUAL

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PROJECT MANUAL

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PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other Conditions, if any) and all other applicable Divisions, apply to work of this Section.

D. Refer to Section 07841 for Through-Penetration Firestop Systems.

E. Refer to Section 08311 for Access Doors and Frames.

1.2 WORK INCLUDED

A. Refer to Section 220005: SCOPE OF WORK - PLUMBING

B. Provide labor, materials, equipment and supervision necessary to install complete operating Plumbing Systems as indicated the drawings and specified herein, including all work at the site and within the proposed construction areas to accomplish the required work.

1.3 REGULATIONS, CODES AND STANDARDS

A. Work shall be performed in accordance with latest adopted codes, regulations and ordinances by authorities having jurisdiction. Observe all safety regulations.

B. Latest editions of any referenced standards shall govern.

C. Obtain all municipal and/or the Authorities Having Jurisdiction permits and inspection certificates and pay all charges.

D. Make or arrange for any/or all inspection agency reviews or visits and pay all charges. This includes communication with each respective agency and/or utility to verify the project system work, coordination responsibilities, fees, back charges, etc., required.

E. All fees and back charges shall be verified during the bidding phase of the work. Any discrepancy of this item between any utility, inspection agency and the Contractor shall be brought to the attention of the A/E prior to bid opening.

F. Submission of a bid will be deemed evidence of having complied with these requirements.

1.4 RELATED WORK

A. Refer to equipment shown or specified in all other applicable Divisions that require Plumbing and Fire Protection services.

B. Refer to work related to Plumbing and Fire Protection as shown on the following contract drawings:

Architectural & Structural
HVAC
Electrical

1.5 COORDINATION

A. The Mechanical, Plumbing and Electrical Contractors are responsible to coordinate all manufacturer's recommended circuit breakers, starters, disconnects and fuse sizes for all equipment. Submission of a shop drawing will certify that this has been completed. Any necessary changes required will be included as part of this contract.

B. Plumbing and Sprinkler Contractors shall coordinate scheduling, submittals and work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of independent work elements, with provisions to accommodate items that may be installed at a later time.

C. Plumbing and Sprinkler Contractors shall verify utility requirements and all characteristics of operating equipment are compatible with the building utilities. Coordinate the work of all sections related and required for installing, connection and placing in service of all equipment.

D. Plumbing and Sprinkler Contractors shall coordinate all space requirements, supports and installation of all mechanical, electrical, plumbing and fire protection work, which are indicated diagrammatically on the Drawings. Verify routing of all pipes, ducts, conduits and equipment connections. Maximize accessibility for other work, and service requirements for maintenance and repairs.

E. Obtain written confirmation from all related trade Contractors and the Owner or his representative that requirements, conflicts and coordination issues have been discussed and resolved.

1.6 SUBMITTALS

A. Shop Drawings & Product Data:

1. Shop drawings and product data shall be submitted in accordance with Division 22 specifications except where herein modified.

2. Listed are the required shop drawings and reports required for this project. The Engineer/Owner shall reserve the right to require additional submissions not listed below:

- All fixtures, equipment and associated devices so listed on the Fixture Schedule on Drawing _____.
- Insulation
- All specified piping systems.
- All specified valves.
- Gauges and thermometers
- Recirculating pump.
- Hanger and supports including Sumner system.
- Piping labels and identification.

- Testing reports.

- Operating/Maintenance manuals.
- As-Built Drawings.

3. Submittals comprising complete catalog cuts, shop drawings and performance test data for Plumbing materials and equipment as required by other sections of Division 22, shall be submitted for review checking. The Contractor shall review these for conformance to contract documents prior to submission and affix contractor's signature to each submittal certifying that this review has been done. By approving and submitting shop drawings, product data, samples and similar materials, the Contractor represents that the Contractor has determined and verified materials, field measurements and field construction data that relates to the work, and has checked and coordinated this information with all of the requirements contained in the contract documents for the work of all trades.

4. All submittals shall have the following identification data, as applicable, contained therein or permanently adhered thereto.

   a. Project name.

   b. Project number.

   c. Sub-contractor's, vendor's and/or manufacturer's name and address.

   d. Product identification.

   e. Identification of deviation from contract documents.

   f. Applicable contract drawings and specification section number.

   g. Shop drawing title, drawing number, revision number, and date of drawing and revision.

   h. Resubmit revised or additional submittals as requested.

   i. Wherever shop drawings or vendor's standard data sheets indicate work to be done "by others", it shall be the responsibility of the contractor making the submission to identify by name, the contractor who is to do this work. If the contractor named is other than the contractor making the submission, the shop drawing submission must be reviewed by the named contractor and bear his mark of approval, prior to submission to the Architect/Engineer.

   j. Where equipment proposed differs from that shown on the drawings or specified, he shall submit for approval drawings showing the manner in which the layout is affected by the substitution.

   k. The Contractor shall keep one copy of approved shop drawings at the job site,, filed in a suitable metal container. The shop drawings shall be cataloged and kept in good repair, and shall be available for use by the Owner, Architect and Engineer.

l. No equipment shall be ordered, fabricated, etc., before approval of shop drawings.

B. Contractor shall be responsible for the shop drawing coordination and interface with the work of other contracts and adjacent work. The relationship of Contractor's work shall be verified as it relates to adjacent and critical features of the work of this and all contracts and materials.

1.7 WARRANTY/GUARANTEE

A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in all other applicable Divisions. In addition, refer to specifications for special guarantees.

B. Wherever in the specification sections of this division, reference is made to a specific warranty period, this warranty shall be in addition to and not a limitation of other rights the Owner may have against the Contractor under the contract documents.

1.8 SITE INSPECTION

A. The Contractor shall visit the site, inspect, and become aware of all conditions which may affect the work during the estimation phase of his work and prior to bid openings. Investigate utilities, protection requirements for adjacent facilities, storage locations, and access to the construction area.

B. Submission of a bid will be deemed evidence of having complied with this requirement.

1.9 SUBSTITUTIONS

A. Whenever a material, article, piece of equipment or system is identified in the following specification or indicated on the drawings by reference to manufacturers' or vendors' names, trade names, catalog numbers or the like, it is so identified for the purpose of establishing the basis of the Bid.

B. Substitution approval must be obtained and included as an addendum item prior to the submission of the bid. An approved substitution shall not be considered as an approval for the Contractor or an equipment vender to deviate from the written portion of the specifications unless so stated in the addendum.

C. The drawings illustrate the space allocated for equipment and the Contractor shall install the equipment accordingly. If changes are required in the building or arrangement due to substitution of equipment, the Contractor making the substitution must pay for the necessary modifications.

D. The listed equivalent or substituted manufacturers along with the bidding related contractor shall be completely responsible to comply with all requirements as indicated on all contract documents and as described within the specifications. This shall include, but shall not be limited to space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades, including all required ancillary items furnished and installed by other trades. If the manufacturer or related bidding contractor does not comply with these requirements, then they shall be responsible for any and all additional costs associated with the changes required by other trades.

1.10 LUBRICATION

A. Furnish, install and maintain all required lubrication of any equipment operated prior to acceptance by the Owner. Lubrication shall be as recommended by the equipment manufacturer.

B. Provide one year's supply of lubricants to Owner at date of acceptance.

C. Verify that required lubrication has taken place prior to any equipment start-up.

1.11 EQUIPMENT START-UP

A. Verify proper installation by manufacturer or his representative.

B. Advise General Contractor 2 days prior to actual start-up.

C. Verify proper operation. Obtain signed statement by manufacturer or his representative that equipment is operating within warranty requirements. Submit statement to General Contractor.

1.12 OPERATION & MAINTENANCE INSTRUCTIONS

A. Properly and fully instruct Owner's personnel in the operation and maintenance of all systems and equipment.

B. Insure that the Owner's personnel are familiar with all operations to carry on required activities.

C. Such instruction shall be for each item of equipment and each system as a whole.

D. Provide report that instruction has taken place. Include in the report the equipment and/or systems instructed, date, contractor, Owner's personnel, vendor, and that a complete operating and maintenance manual has been reviewed.

E. Manual shall include all instructions on operation, maintenance, repair parts list, lubrication requirements, brochures, catalogue cuts, wiring diagrams, piping diagrams, control sequences, service requirements, names and addresses of vendors, suppliers and emergency contacts. Three manuals shall be provided.

F. Submit manuals for review prior to operating instruction period. Manuals shall be 8-1/2 x 11" with hard cover, suitably bound.

G. Provide to the Owner any special tools necessary for operation and routine maintenance of any of the equipment.

1.13 TOOLS

A. All equipment furnished by the Contractor which requires special tools or devices other than those normally available to the maintenance or operating staff shall be furnished in duplicate to the Owner, sufficiently marked, packed or boxed for staff usage. The tools provided shall be listed by the Contractor identified as to their use or the equipment applicable in a written transmittal to the Owner.

1.14 CLEANING AND FINISHING

A. After equipment start-up and all operating tests have been made and the system pronounced satisfactory, each respective Contractor shall go over the entire project, clean all equipment, etc., installed by him and leave in a clean and working condition. Any surfaces found marred after this final cleaning shall be refinished or replaced by each Contractor at no cost to the Owner.

B. Provide for the safety and good condition of all materials and equipment until final acceptance by the Owner. Protect all materials and equipment from damage. Provide adequate and proper storage facilities during the progress of the work. Special care shall be taken to provide protection for bearings, open connections, pipe coils, pumps, compressors and similar equipment.

C. All NEW fixtures, piping, finished surfaces and equipment installed shall have all grease, adhesive labels and foreign materials removed.

D. All new piping installed shall be drained and flushed to remove grease and foreign matter. Pressure regulating assemblies, traps, flush valves and similar items shall be thoroughly cleaned. Remove and thoroughly clean and reinstall all liquid strainer screens after the system has been in operation ten (10) days.

E. Gas piping shall be blown out with clean compressed air or inert gas.

F. When connections are made to existing systems, the Contractor shall do all cleaning and purging of the existing systems required to restore them to the condition existing prior to the start of work.

G. Clean-up: Remove from the premises, all unused material and debris resulting from the performance of work under this section.

PART 2 PRODUCTS

2.1 GENERAL

A. All material and equipment shall be new and of present day manufacture, and shall conform to accepted standards of the trade where such a standard has been established for the particular type of equipment or material.

B. Whenever equipment or material is referred to in the singular, such as "the plumbing fixture", it shall be deemed to apply to as many such items as necessary to complete the work.

2.2 PRODUCT DELIVERY, STORAGE AND HANDLING

A. During loading, transporting and unloading exercise care to prevent damage to material.

B. Store all materials in dry enclosures or under protective coverings out of way of work progress.

C. Material shall not be allowed to be stored directly on ground.

D. Deliver in manufacturer's original cartons or on skids.
E. Handle and protect so as to prevent damage to product or any surrounding material.

PART 3 EXECUTION

3.1 PROTECTION

A. Plug or cap open ends of piping systems.

B. Stored materials shall be covered to prevent damage by inclement weather, sun, dust or moisture.

D. Plates, polished metal escutcheons and other finished devices shall not be installed until masonry, tile, and painting operations are complete unless otherwise protected.

E. Protect all work from operations which may cause damage such as hauling, welding, soldering, painting, insulating and covering.

F. Do not remove protective material until equipment is placed in service.

3.2 WORKMANSHIP

A. Install all work neat, trim and plumb with building lines.

B. Install work in spaces allocated.

C. Cutting and patching shall be performed by skilled tradesmen normally employed for the work involved.

3.7 FASTENERS, HANGERS AND SUPPORTS

A. Furnish and install all hangers and supports required to suspend, mount, or hang the work.

B. Furnish and install all miscellaneous steel angles, channels, beams, clips, brackets and anchors necessary to hang or support the work. Provide submissions for review.

C. Install concrete inserts before concrete is poured.

D. Drilled inserts shall not be loaded more than 1/4 rated capacity or 200 pounds.

E. Power-driven fasteners shall not be allowed for piping larger than 2 inch, or equipment. When used they shall not be loaded more than 1/8 rated capacity or 200 pounds.

F. All hangers, miscellaneous steel, braces and supports shall be galvanized, cadmium plated, or primed steel. Copper tubing shall be supported with copper hangers. No direct contact of dissimilar metals between the piping system and its hanger support shall be permitted.

G. Piping shall be supported from adjustable clevis type hangers with insulation pipe saddles. Where hangers are 18” or longer, provide lateral bracing at every fourth hanger. See IPC Pipe Support Table below:

H. Support vertical piping at floor levels using approved riser clamps. Clamp material shall be compatible with pipe material. Maximum vertical spacing shall be10’-0”.

3.8 SLEEVES

A. Provide each pipe passing through a masonry or concrete wall, floor or partition with a sleeve made from standard weight steel pipe for pipe with smooth edges, securely and neatly cemented in place. Provide each pipe passing through a frame or metal partition with a sleeve made from No. 22 gauge galvanized sheet metal, securely fastened in place.

B. Pipe passing through foundation wall or under foundation shall be provided with relieving arch or steel pipe per IPC Section 305.5.

C. Be responsible for the proper location and alignment of all sleeves.

D. Provide hydrostatic seals for sleeves passing through outside walls, below grade, or through hydrostatically sealed slabs or floors on grade. Provide fire-rated seals for all other sleeves.

E. Install both piping and sleeve seals so as to maintain integrity of seals with expansion and contraction of piping.

F. Set floor sleeves flush with floor surface in finished areas, 1" above the finished floor in kitchens, cafeterias, and similar service areas unless such areas are slab-on-grade; 1" above the floor in mechanical rooms, pipe chases, pipe spaces and other unfinished areas, unless otherwise indicated, and flush with the underside of slabs. Extend wall and partition sleeves through and cut flush with each surface unless otherwise indicated or specified.

G. Select sleeves two pipe sizes larger than any pipe that is to remain uncovered, unless otherwise required by the sealing method specified. Where pipes are to be covered, provide sleeves large enough to allow the covering to pass through the sleeves with sufficient clearance for sealing as

specified hereinafter. Size sleeves for branch piping from vertical risers large enough to permit vertical expansion at the riser.

H. Place sleeves imbedded in concrete floors or walls in the forms before concrete is poured; sleeves shall have integral waterstop flanges, where they are to receive either watertight or hydrostatic seals.

I. Install sleeves passing through above-grade floors of mechanical rooms, toilet rooms, kitchens or similar service areas where liquid leaks or spillover may occur in a watertight manner. Sleeves shall be such that waterproofing membrane can be flashed around and into the sleeve where necessary.

J. Seal sleeves for pipes passing through ceiling air plenum walls or the floor above air tight in a manner similar to that specified for fire-rated sleeves.

K. Hydrostatic Sealing Method: Provide compressible synthetic rubber seals, equivalent to LINK SEAL, manufactured by the Thunderline Corporation, or THRUWALL manufactured by O.Z. Gedney. Install seals in accordance with the manufacturer's recommendations to provide air tightness aboveground and hydrostatic sealing belowgrade. Caulking or other type mastic is not acceptable.

L. Fire-Rated Sealing Method:

1. Fire stopping of all thru-penetrations of fire and/or smoke rated assemblies (partitions, floors, ceilings, etc.) shall be the responsibility of each installer or building trade (Mechanical, Plumbing, Electrical, Communications, Data, etc.) making the thru-penetrations, unless otherwise indicated on the Architectural series drawings (A-series). It is the responsibility of the Contractor making the thru-penetrations to verify and coordinate fire stopping with fire rating, assembly type and field conditions.

2. Sleeves, openings and sealants shall comply with applicable codes, recommended practices and standards, and manufacturer's instructions. Fire sealants shall have ability to prevent spread of flame, smoke or water throughout the penetration and shall pass 3 hour test, UL test ASTM E814 and UL 1479.

3. Products: Refer to Division 7 of the specifications for Fire Stopping Requirements.

3.9 PLATES

A. Furnish and install chrome plated plates wherever piping passes into finished area.

B. Plates shall be securely fastened to piping or building construction.

C. Floor plates shall cover 1 inch sleeve extension.

3.10 OFFSETS, TRANSITIONS, MODIFICATIONS

A. Furnish and install all offsets necessary to install the work and to provide clearance for other trades.

B. Maintain adequate headroom and clearance.

C. Incidental modifications necessary to the installation of the systems shall be made as necessary and as approved by the Architect.

3.11 RECESSES

A. Furnish information to the General Contractor as to sizes and locations of recesses required to install panels, boxes, and other equipment or devices which are to be recessed in walls.

B. Make offsets or modifications as required to suit final locations.

3.12 LABELING

A. All Plumbing equipment such as pumps, and devices requiring identification for operating procedures shall be provided with permanent black laminated micarta white core labels with 3/8 inch letters.

B. This shall also apply to all controllers, remote start/stop pushbuttons and equipment cabinets.

3.13 FLASHING AND COUNTERFLASHING

A. Roof drains, vents, roof curbs, etc., shall have counterflashing fittings. General Contractor shall provide flashing.

B. Piping and conduit thru the roof shall be flashed by the General Contractor. Furnish and install counterflashing.

3.14 ACCESS

A. Locate all equipment, valves, devices and controllers which may need service in accessible places.

B. Where access is not available, access panels shall be provided. Furnish access doors to the General Contractor for installation.

C. Access doors shall be Elmdor, Karp Co., MIFAB or Controlled Air Manufacturing Limited, with 16 gauge frames and 14 gauge steel door, prime painted.

C. Maintain required access clearances.

3.15 WIRING

A. Packaged plumbing system equipment shall be furnished with disconnect switches, and magnetic starters, factory furnished and wired by the unit manufacturer.

B. All control wiring shall be furnished and installed under this Division of the work.

C. All wiring shall be in accordance with the National Electrical Code and as recommended by the equipment manufacturer.

3.16 UTILITIES

A. Do not interrupt any utility or service to the Owner without adequate previous notice and schedule.

B. Arrange and pay for the relocation, disconnection or removal of, or relocate, disconnect or remove existing utilities and services where such work is shown or where such utilities or services interfere with new construction, whether or not shown. Provide all excavation, backfilling and paving required by such work.

C. Perform alteration of utilities and services in accordance with the rules, regulations and requirements of the involved utility companies, regulatory agencies having jurisdiction.

3.17 CUTTING AND PATCHING EXTERIOR SURFACES

A. This Contractor shall be responsible for returning disturbed paved and/or grass areas to original condition where excavation for utilities has been required.

B. Cut and patch paved areas to match original surface.

C. Properly tamp backfill before finishing or repairing disturbed area surfaces.

3.18 OPENINGS - CUTTING, REPAIRING

A. This contractor shall cooperate with the work to be done under other sections in providing information as to openings required in walls, slabs and footings for all piping and equipment, including sleeves where required.

B. Any drilling or cutting required for the performance of work under this Section, shall be the responsibility of this Contractor and the cost thereof shall be borne by him.

C. Holes in Concrete: Sleeves shall be furnished, accurately located and installed in forms before pouring of concrete. This contractor shall pay all additional costs for cutting of holes as the result of the incorrect location of sleeves. All holes through existing concrete shall be either core drill or saw cut. All holes required shall have the approval of the Structural Engineer prior to cutting or drilling.

D. It shall be the responsibility of this Contractor to ascertain that all chases and openings are properly located.

3.19 GUARANTEE

A. All materials and equipment provided and/or installed under this section of the specifications shall be guaranteed for a period of one year from the date of acceptance of the work by the Owner unless otherwise specified in other applicable Divisions. Should any trouble develop during this period due to defective materials or faulty workmanship, the Contractor shall furnish all necessary labor and materials to correct the trouble without any cost to the Owner. Any defective materials or inferior workmanship noticed at time of installation and/or during the guarantee period shall be corrected immediately to the entire satisfaction of the Owner.

In the event of occupancy by the Owner prior to final acceptance of the project, the guarantee date for equipment placed in operation shall be mutually agreed to by the Contractor and the Owner's representative.

3.20 DRAWINGS

A. The Plumbing Systems are indicated on the Contract Drawings. Certain information and details required by the Plumbing Work appear on the Architectural, Structural and Electrical Drawings; become familiar with all Drawings; and incorporate all pertinent requirements.

B. Drawings are diagrammatic and indicate the general arrangement of systems and requirements of the Work. Do not scale Drawings. Exact locations of fixtures and equipment, not specifically shown shall be obtained before starting work.

D. When indicated on the drawings, plumbing riser diagrams are completely diagrammatic and indicate the intent of the work for both the Contractor, review agencies and/or Authorities Having Jurisdiction. Where valves, shock absorbers, incidental equipment, devices, etc., including execution notes are indicated on the riser diagrams, they shall be so required and installed as part of the system work.

3.21 RECORD DRAWINGS

A. As-Built record drawings, showing dimensions, locations and depth of all buried and concealed piping, plugged outlets and equipment shall be kept up to date. Master copy shall be kept on the job. No backfilling of trenches shall be permitted until as-built drawings are approved as up-to-date by the Owner/Representative. No plumbing progress payments shall be approved unless as-built drawings are up- to-date. Depth of sewers shall be from a permanent bench mark as shown on the contract drawings. Refer to project record drawings under General Conditions.

END OF SECTION 220000

SECTION 220010: BASIC MATERIALS AND METHODS - PLUMBING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this Section.

1.2 REFERENCE

A. Install all piping, fixtures, equipment, etc., to meet the requirements of the following:

New Castle County Department of License and Inspection
_____Department of Sewers
_____Plumbing Code
_____Fire Marshal's Office
BOCA Basic Plumbing Code
BOCA Basic Mechanical Code
International Plumbing Code
International Fuel Gas Code
Gas Utility Company
Water Company
NFPA

All requirements of the above governing agencies shall be in compliance with the latest issues, rules or regulations in effect.

B. Appliances and materials governed by UL requirements shall meet such requirements and bear the label.

1.3 QUALITY ASSURANCE

A. Provide adequate supervision of labor force to assure all aspects of specifications are being fulfilled.

B. Insure that all work and equipment is installed in accordance with manufacturer's warranty requirements.

C. Replace all pipes and fittings shown to be defective as a result of testing.

1.4 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 220000.

B. Submit the following:

1. Manufacturer's Product Data on all pipe and fittings to be used in project.

2. Manufacturer's Product Data on all valves to be used in project.

1.5 WARRANTY/GUARANTEE

A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, GENERAL REQUIREMENTS.

PART 2 PRODUCTS

2.1 STEEL PIPE & FITTINGS

A. Pipe: ASTM A-53, seamless, Schedule 40.

B. Fittings:

1. Cast iron, threaded, 175 psi, ANSI B-16.4.
2. Malleable iron, threaded, ASA B 16.3.
3. Steel, socket weld, ASTM A-53.
4. Wrought iron, socket weld, ASTM A-72.

C. Thread tape shall be teflon tape, 3 mils minimum thickness. Teflon tape shall not be permitted for use on gas piping systems.

D. See Section 220130 for Gas Piping Systems.

2.2 CAST IRON PIPE AND FITTINGS

A. Aboveground:

1. Pipe & Fittings: Hubless cast iron, CISPI 301, ASTM A-74 and ASTM A-888 shall be marked with the collective trademark of the Cast Iron Institute (soil pipe).

2. Joints: Neoprene sleeve and stainless steel shield and clamp assembly, CISPI 310, ASTM-1277.

B. Below grade and/or slab:

1. Bell and Spigot: Service weight bell and spigot pattern ASTM-74 with compression type neoprene gaskets ASTM C-564.

2. Hubless: Hubless cast iron pipe CISPI 301, with heavy duty 3.04.016 stainless steel bands for below-grade installation. Elastomeric seal component ASTM C-564 and CSA B-602.

3. Hubless Joints: Cast iron CISPI 310 and asTM C-1277.

4. PVC DWV pipe and fittings, Schedule 40, ASTM D-2665, D2949, F891 and CSA B181.2.

5. Corrosion protection shall be in accordance with IPC 305.1. Provide appropriate wrapping or sheathing when pipe is exposed to lime and acid of concrete, cinder or other corrosive materials.

6. Protection of all below-grade storm and sanitary shall be in accordance with IPC Section 305.

7. All Kitchen and Boiler Room below slab piping shall be extra heavy schedule cast iron only. PVC not allowed.

C. Corrosion protection shall be in accordance with IPC 305.1. Provide appropriate wrapping or sheathing when piping is exposed to lime and acid of concrete, cinder or other corrosive materials.

2.3 COPPER TUBING

A. Domestic hot, cold and recirculated water:

1. Aboveground:

a. Tubing: Hard-drawn, seamless ASTM B-88, Type "L".
b. Fittings: Solder joint wrought copper ANSI B-16.22.
c. Joints: Lead-free solder 410°, ASTM B-32 alloy designation “TC”, ASTM B-828.
d. Flux: Non-toxic and non-corrosive, ASTM B-813.

2. Underground:

a. Tubing: Soft-drawn, seamless ASTM B-88, Type "K".
b. Fittings: Solder joint wrought copper ANSI B-16.22.
c. Joints: Lead-free solder 410°, ASTM B-32, ASTM B-828.
d. Flux: Non-toxic and non-corrosive, ASTM B-813.

B. Drainage and vent piping:

1. Aboveground:

a. Tubing: Hard-drawn seamless ASTM B-88, ASTM B-75, Type "M" and DWV as pipe size permits.
b. Fittings: Solder joint cast copper drainage type ANSI B-16.29.
c. Joints: Soldered, 95/5 tin-antimony ASTM B-828, ASTM B-32.
d. Flux: Non-toxic and non-corrosive, ASTM B-813.

C. Solder/Flux: See Paragraph 3.4 of this section for Soldering/Brazing.

2.4 DUCTILE IRON PIPE

A. Pipe: Ductile iron, ANSI A-21.51, ANSI/AWWA C151.

B. Joints: Rubber gasket, ANSI A-21.11, ANSI/AWWA C111.

C. Fittings: Mechanical joint, ANSI/AWWA C110, C153 bolt tolerances – AWWA C-111, ASTM A-563.

D. Lining: Cement mortar, ANSI A-21.4, ANSI/AWWA C104.

2.5 PVC GRAVITY SEWER PIPE

A. Pipe: Unplasticized polyvinyl chloride (PVC) with integral wall ball and spigot joints.

B. Material: ASTM D-3034 for SDR 35, colored green for inground identification as sewer pipe.

C. Joints: Two sections of pipe shall be assembled in accordance with manufacturer's recommendations and tested as per ASTM D 3212 for use with flexible elastomeric seals.

D. Sizes: For site drainage systems 4" to 15".

E. Additional compliances:

1. Drop Impact Test - ASTM D-2444
2. Pipe Stiffness - ASTM D-2412
3. Temperature for Testing - Designed to pass all tests at 73 degrees F (+/- 3 degrees F).

2.6 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

A. Underground – Drainage & Vent (Sanitary) IPC Table 702.2

1. ASTM D 2665
2. ASTM D 2949
3. ASTM F 891
4. CSA CAN/CSA-B 181.2

B. Building Sewer Pipe (Near Water Service) IPC Table 702.3 (DWV)

1. ASTM D 2665
2. ASTM D 2949
3. ASTM D 3034
4. ASTM F 891
5. CSA B182.2
6. CSA B 182.4

C. Fittings:

1. ASTM D 3311
2. ASTM D-2665
3. ASTM F-1866

D. Solvent Cement:

1. ASTM D-2564
2. CSA B137.3
3. CSA B181.2 or B182.1 (Sanitary Pipe only)
4. ASTM D2855

F. Primers:

1. ASTM F 656

G. Uniformity: To insure installation uniformity, all piping components shall be of one manufacturer.

2.7 VALVES

A. Valves listed below shall be for domestic water systems and comply with the latest requirements of NSF 61-8.. Refer to individual sections for gas valves.

B. Ball Valves: NIBCO two piece, full port, 600 psi WOG rated, cold non-shock valve with reinforced TFE seals, 316 stainless steel ball, Eco-brass body, ASTM 584, Alloy C87850, solder ends, or threaded non-blowout stem design. Acceptable NIBCO figure numbers: T/S 685-80-66-LF; T/S 595-Y-66-LF (3 piece).

C. Check Valves: NIBCO Class 125, Eco-brass body, ASTM 584, Alloy C87850, swing type, Y Pattern, threaded cap access. Acceptable NIBCO figure number: T/S 413-LF.

D. GateValves: NIBCO Class 125, Eco-Brass body, ASTM 584, Alloy C87850, Rising Stem. Acceptable NIBCO figure number: T/S 113-LF.

E. Balance Valves: All balance valves shall be provided with a memory stop feature with calibrated name plate to assure specific valve setting. Bronze body/brass ball, carbon filled TFE seat rings. NIBCO, Bell & Gosset, Accu-Flow, Taco or Flow Design "Accusetter". Acceptable NIBCO figure numbers: T/S 1710, F/G 737.

F. Strainers:

1. Class 125 Bronze Y-Strainer, body to be ASTM B584 or B62 bronze with threaded, solder or female press end connections and .033 inch perforated type 304 stainless steel screen or 20 mesh type 304 stainess steel screen accessible without removing the strainer from the line. Acceptable Figure numbers: NIBCO Fig. S/T-221, S/T-222, PF-221/222-A,B.

2. Class 125 Flanged Cast Iron Y-Strainer, body to be ASTM A-126 Class B cast iron. End connections to be Class 125 flanged, tapped bolted bonnet with plug. Screen shall be .033 inch perforated type 304 stainless steel screen or 20 mesh type 304 stainless steel screen accessible without removing the strainer from the line. Acceptable Figure numbers: NIBCO Fig. F 721-A.

3. Class 250 Threaded Cast Iron Y-Strainer: Strainer body to be ASTM A-126 Class B cast iron. End connections to be Class 250 threaded, tapped screw-in bonnet with plug. Screen shall be .033 inch perforated type 304 stainless steel screen or 20 mesh type 304 stainless steel screen accessible without removing the strainer from the line. Acceptable Figure numbers: NIBCO Fig. T-751-A

G. Insofar as possible, all valves of the same type shall be of the same manufacturer.

H. Valve Manufacturers: Subject to compliance with requirements, provide valves of one of the following:

Apollo/Conbraco
Stockham
Nibco
Watts

I. System Application:

1. Domestic Water:

   a. Check Valves - 2" & Smaller - threaded or soldered.
   b. Ball Valves - 3" & Smaller - threaded or soldered.
   c. Balance Valves - All sizes - threaded.
   d. Butterfly Valves – 3" and smaller – wafer type.

2.8 THERMOMETERS

A. Separable socket, inserted into fluid flow, adjustable, hermetically sealed, red mercury, die-cast, baked enamel finish, double strength glass lens, white scale and black graduations.

B. Scale: Select range of thermometer to indicate normal operating temperature at mid-point of scale for domestic water systems.

C. Manufacturer: U.S. Gauge, H.O. Trerice, Moeller

2.9 GAUGES

A. Phosphor bronze bourdon tube, polypropylene case, gasketed glass crystal, aluminum dial, black graduations 4-1/2 inch diameter.

B. Range: 0 to 150 psi, 5 pound intervals, 1/2 pound graduations.

C. Manufacturers: Danton, U.S. Gauge, H.O. Trerice, Moeller.

D. Install with bronze gauge cock.

2.10 ISOLATING FITTINGS

A. Furnish isolating fittings between all sections of dissimilar piping materials or piping, general supports, equipment and supports, including piping hanger and rack supports where one material is ferrous and the other is non-ferrous.

B. Install copper or brass piping or tubing in such a way as not to touch or come in contact with ferrous metals.

C. Where ferrous piping or equipment is connected to copper or brass piping, make connection with insulating or dielectric unions to prevent electrolytic action between the ferrous and non-ferrous metals.

D. Where copper or brass piping, tubing or fittings are anchored to, supported by or may come in contact with ferrous metal construction, provide an insulating nonconductor spacer of rubber, fiber or equivalent material to assure prevention of electrolysis.

E. Manufacturer: Epco Sales, Inc., or insulated unions by Central Plastic Co.

2.11 ANCHORS AND GUIDES

A. Anchors and guides shall be provided to support and maintain pipes in position and properly distribute expansion. The anchors and guides must be securely fastened to the building structure, and must be completely installed before the system is tested.

B. Guides shall be as manufactured by J.J. McNally, Inc., Flexonics, Inc., Tube-Turns, American District Steam Co.

2.12 UNIONS

A. Up to and including 2 inch pipe size: Screwed pattern, bronze-to- bronze seat.

B. Above 2 inch pipe size: 125 Class Flanged pattern, A.S.A. sweat copper fitting, with gaskets, bolts and nuts.

C. Copper tubing unions shall have sweated type ends. Flanged unions on copper tubing may be soldered connections.

D. Materials and pressure ratings shall be the same as specified for the respective pipe and fitting system unless otherwise specified.

PART 3 EXECUTION

3.1 PIPING SYSTEM INSTALLATION REQUIREMENTS

A. Drawings are generally diagrammatic and due to small scale, it is impossible to indicate all fittings, valves, gauges and specialties required. Provide complete operating systems and all necessary fittings, valves gauges and specialties whether or not indicated.

B. Install all piping in accordance with the best practices of the trade and latest code requirements. Use uniform system materials throughout the building. All branch take-offs shall be off the top of the pipe.

C. Pipe and fittings shall be clean from cutting burrs, foreign materials and defects in structure and threading. Make all cuts square. Ream after cutting. Clean off scale and dirt inside and outside, before assembly. Remove welding slag or other foreign material.

D. Keep all piping as high as possible, consistent with proper pitch, to maintain maximum headroom. Cut piping accurately to measurements established at the building, work into place without springing, forcing or cutting of the building structure, and install as directly as possible between connecting points parallel with or at right angles to building construction, except as required to obtain pitch.

E. Unless otherwise shown, run piping within the building, concealed in the walls, furred spaces, pipe spaces or above suspended ceilings. Unless otherwise noted, do not build in or bury horizontal piping in partitions. Install all exposed piping as closely as possible to walls, ceilings and columns, consistent with access and applicable insulation requirements.

F. This project includes a return air plenum ceiling. Regardless of materials specified, all system piping and/or materials shall be non-combustible and shall be in full compliance with the requirements set forth in the IPC.

G. All piping to drain to low points. Low points will be provided with drain valves with hose thread. All piping shall have high points vented with ball valve, nipple and threaded cap.

H. Do not install trapped lines where water cannot be drained or air can accumulate without being vented.

I. Piping shall run square with building lines.

J. Piping shall not be insulated or covered until tested and until building is closed in.

K. Necessary drains, off-sets, vents and drips shall be provided for coordination of the work as part of the contract.

L. Piping shall not be installed over electrical transformers, panels, switchgear, substations, and control panels as per the National Electric Code. No piping shall be installed in elevator machine rooms unless it is directly related to the room's system equipment.

M. Allow clearance for expansion and contraction.

N. Install isolating fittings between sections of ferrous and non- ferrous pipe or connected equipment.

O. Valves shall be installed with stems above horizontal.

P. Valves shall be installed on all sides of equipment and control valves to allow isolation for repair.

Q. Do not support piping from other piping, conduits or equipment. Provide additional bracing to prevent movement of trapeze piping, or any singular run of pipe to fixtures. Provide additional bracing on all piping through walls to flush valves to prevent movement during normal operation or performing maintenance on valves.

R. Thermometers and gauges shall be installed where indicated on the drawings, required by equipment specifications and where indicated elsewhere in the specifications. Gauges shall be located at an elevation that can be readable.

S. Unions shall be provided adjacent to all valves, at equipment connections, and where necessary to facilitate dismantling of the piping system.

T. Ball valves to be installed with the proper clearance for operating the valve handle. A minimum clearance of 10" from center of valve to wall must be maintained for ease of operation.

U. Thermometers are to be located so they can easily be seen from the floor in front of unit. Make final adjustment by tilting thermometer. Locate bulb in waterway with an oversized tee or elbow fitting.

V. Install pressure gauges on incoming services both domestic water and fire services. Locate pressure gauge after main shut-off valve and ahead of water meter if one is provided within building.

W. All pipe unions installed shall be accessible. Unions shall not be concealed or located in places where they cannot be maintained.

3.2 TAGS, CHARTS, AND IDENTIFICATION

A. All piping shall be labeled in accordance with IPC 303.1 and 303.4.

B. Identify each valve in all systems with black, numbered and stamped 1-1/2" brass or aluminum tags fastened to valve by brass chain and S-hook.

C. Piping Identification: Provide identification and safety products, semi-rigid plastic, wraparound pipe markers with flow arrows and conforming to ANSI A13.1. Locate marker at each valve, changes in direction, where pipes pass thru barriers and every 25' of horizontal runs. Lettering on background shall be in accordance with the following colors:

Legend	Background	Lettering
1. Gas	- Yellow	- Black
3. Domestic Cold Water	- Green	- White
4. Domestic Hot Water (110° ^ 140°)	- Yellow	- Black
5. Domestic Hot Water Return (110° ^ 140°)	- Yellow	- Black
6. Sanitary Drainage	- Green	- White
7. Condensate Drainage	- Yellow	- Black
8. Vent	- Yellow	- Black
9. Storm Drainage	- Green	- White
9. Storm Drainage	- Green	- White

D. Provide 1/8" scale diagrams showing location, number and service or function of each tagged item.

1. Frame diagrams in approved metal frames with clear acrylic front, hinges, and locks.

2. Secure to wall in Mechanical Room.

3. Provide two additional separate copies permanently covered and bound.

F. Available Manufacturers: Subject to compliance with requirements, manufacturer's offering identification markers which may be incorporated in the work are limited to the following:

Seton
Brimar
B-Line
Marking Services, Inc.

3.3 WELDING

A. All concealed and inaccessible black steel piping shall be welded.

B. All black steel piping larger than 2 inch shall be fusion welded.

C. All elbows, tees and branch connections shall be made with welding fittings ANSI B16.9.

D. Welding shall be in accordance with the ASME Boiler and Pressure Vessel Code Section IX.

E. Furnish welder test certificate for review. Certificates of successful qualification by the following organizations shall be acceptable.

1. ASME Boiler and Pressure Vessel Code
2. ANSI Code for Pressure Piping
3. National Certified Pipe Welding Bureau
4. Military Specification MIL-STD-248

3.4 SOLDERING/BRAZING

A. Connections between copper tubing and copper sweat fittings shall be made by soldering using Taramet Sterling or approved substitute. Flux shall be non-corrosive type "Nokorode" or approved substitute or as recommended by the manufacturer of the solder.

B. All solder shall be "lead nickel and antimony free" in accordance with the Federal Safe Drinking Water Act Amendments of 1986 and 1996 as is ASTM B-32 Grade TC.

Composition:

Tin	95%
Copper	4.0 – 5.0%
Selenium	.04 - .2%
Tensile Strength	7,130 psi
Shear Strength	5,970 psi
Melting temperature	410°F

C. Tubing shall be cut square and then reamed and deburred. End of tubing and inside of fitting cup shall be cleaned with steel wool and the flux shall be applied to the clean surface before soldering. After soldering, the excess solder shall be wiped off while still plastic.

D. Silver brazing alloy shall be equal to and shall be used for joints in:

1. Medical Gas Piping (All Systems)
2. Medical Vacuum Piping

E. Brazed Joints:

1. All brazed joints shall be cleaned. An approved flux shall be applied, joint filler metal shall conform to AWS A5.8.

2. Flux shall meet AWS Standard A5.31, Type F83-A or F83-C.

F. 410 solder shall be used for all joints in:

1. Domestic cold water
2. Domestic hot water
3. Domestic hot water return
4. Copper drainage piping
5. Plant compressed air

G. Lead-Tin (50-50) solder or any solder containing lead shall **NOT** be used or permitted for joint connections on this project.

H. Where the silver brazing is performed in a confined non-ventilated space, a non-toxic, cadmium-free brazing alloy such as Stay-Brite shall be used instead of Easy-Flo. Bring joint to solder temperature or brazing temperature in as short a time as possible.

I. Form continuous solder bead or brazing filler bead around entire circumference of joint.

J. Wipe excess solder from joint area while solder is still plastic.

K. Solder joints shall be in accordance with IPC Section 605.2, 605.14.3 and ASTM B838. Flux shall conform to ASTM B-813.

3.5 PRESS-FIT SYSTEM

A. All new domestic water piping installed on this project shall be a solderless, press-fit, domestic water system. The system shall be Viega/Rigid copper press fitting system. Fittings shall be rated 0□ to 250□ at 200 psi and tested to 600 psi.

B. Fittings shall meet ANSI/NSF 61, – ASME B-16.22 and ASTM B88. Elastomeric seals shall meet ASTM D-2000.

C. Mechanical joining shall be recognized by:

IPC International Plumbing Code
SBCCI Standard Plumbing Code
IAPMO Uniform Plumbing Code
PHCC National Standard Plumbing Code

D. Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117. Sealing elements for press fittings shall be EPDM. Sealing elements shall be factory installed or an alternative supplied by fitting manufacturer. Press end shall have SC (Smart Connect) feature design (leakage path). Smart Connect™ (SC Feature). In ProPress ½" to 4" dimensions, the Smart Connect Feature assures leakage of liquids and/or gases from inside the system past the sealing element of an unpressed

connection. This feature shall provide the installer quick and easy identification of connections which have not been pressed prior to putting the system into operation.

E. Press Connections: Copper press fitting joints shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool approved by the manufacturer.

F. Installer shall be a qualified installer, licensed within the jurisdiction, and familiar with the installation of ProPress copper press joint systems. ProPress copper press fittings shall be installed using the proper tool, actuator, jaws and rings as instructed by the press fitting manufacturer. The installation of
copper tubing for hot and cold water distribution systems shall conform to the requirements of the ICC International Plumbing Code or IAPMO Uniform Plumbing Code.

G. Note: Viega Press-fit installation shall only be permitted on this project. Push-on shark-teeth, or any type connection fittings that are not Press-Fit, shall NOT be approved.

END OF SECTION 220010

SECTION 220030: INSULATION & COVERING - PLUMBING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the Work specified in this Section.

1.2 DESCRIPTION OF WORK

A. Refer to Section 220005 for a general description of the scope of work in this contract.

B. This section includes insulation and covering furnished and installed on the following piping systems and equipment:

1. Domestic cold water.
2. Domestic hot water supply and return
3. "Primary" Horizontal rainwater conductors including underside of roof drains. "Secondary" rainwater systems insulation is not required.
4. Hot water storage tanks.
5. Exposed waste, trap and wall supplies at all handicap lavatories.
6. Branch waste lines from all chilled water fountains.

1.3 REFERENCE STANDARDS

A. Refer to Section 220000 for a general description of requirements applying to this section.

B. Materials shall conform to the requirements of the NFPA Code.

1.4 QUALITY ASSURANCE

A. Refer to Section 220010 for a general description of requirements applying to this section.

1.5 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 220000.

B. Submit the following:

1. Product data on all insulation and covering.

1.6 WARRANTY/GUARANTEE

A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, GENERAL REQUIREMENTS.

PART 2 PRODUCTS

2.1 PIPE INSULATION MATERIAL

A. Fiberglass:

1. Material: Preformed fiberglass bonded with resins to form circular pipe sleeves with factory applied, white all-service jacket bonded to reinforced foil vapor barrier jacketing. The jacket shall have factory-applied double pressure-sensitive adhesive closure and vapor sealing of longitudinal joints. Thermal Conductivity: .25 per inch at 100 degrees F. Flame spread of 25 and developed smoke of 50 or less.

2. All Valves and Fittings:

   a. Class fiber insert and premolded PVC cover, Manville "Zeston" and "Hi-Lo Temp Inserts" for valves and fittings.

   b. Factory molded fibrous glass fitting covering for fittings. Cover with canvas.

   c. Mitered sections of pipe covering for valves.

3. Manufacturers: Johns-Manville, Certain-Teed, Owens-Corning.

B. Closed Cell:

1. Material: Flexible elastomeric foamed plastic closed cell structure insulation 25/50 rated with a flame spread rating of 25 or less and a smoke developed rating of 50 or less.

2. Flexible pipe insulation shall be a foamed plastic closed cell structure material, with a thermal conductivity of not more than 0.27 Btu/Hr./Sq. Ft./Inch at a mean temperature of 75 degrees F. The insulation shall have an average density of at least 2 pounds per cubic foot, shall be self-extinguishing, and shall have a water vapor transmission rating of not more than 0.1 perms. Between temperature limits of -40 degrees F and plus 220 degrees F, the insulation shall not indicate any deviation from its original state.

3. Manufacturers: Armacel, Insul-Tube, Nomaco Insulation.

4. Specification Compliance: (Latest accepted Standards and Codes)

IECC 804.5:	Insulation thickness for domestic hot and recirculation mains.
ASTM-E-84	Flame spread and smoke developed.
NFPA 255:	Standard method of test of surface burning of building materials.
ASTM C177:	Thermal conductivity.
NFPA 90A, 90B:	Flame & smoke rating

ASTM-C-534 Type 1 Tubular Grade, Self-Sealing
UL 181 Factory made air ducts and air connectors. (Armacell UL181 has to do with mold growth)
UL723 Test for surface burning characteristics of building materials.
ASTM G21/C1338: Fungi resistance
ASTM G2: Bacterial Resistance
ASTM D1056, 2B1: Standard spec for flexible cellular materials.
MIL-P-15280J, FORMT
MIL-C-3133B (MIL STD 670B) Grade SBE-3
MEA 96-85M

C. Covering of Pipe Insulation Outdoors:

1. Wrapping: Wrap insulation with embossed .016" aluminum jacket.

2. Fastenings: Cover shall be held in place with soft aluminum bands on 12" centers.

3. Valves and Fittings: Weatherproof all valves and fittings.

4. Manufacturers: Johns-Manville, Certain-Teed, Owens-Corning, Knauf.

D. Protective cover for foam insulation in wet areas indoors:

1. PVC heavy duty fitting covers and jacketing for kitchen wet areas.

2. Fitting covers shall be glossy white, high impact, UV resistant PVC.

3. Operating Temperature Limit: Up to 150ºF.

4. Flame Spread: 25 or less.

5. Smoke Developed: 50 or less.

6. Grade: Weatherable.

7. Color: White

8. Finish: Gloss

9. Fitting covers and jacketing shall be “Zeston” 300 Series PVC, heavy duty covers and “Zeston” PVC jacketing.

PART 3 EXECUTION

3.1 INSTALLATION

A. Do not install until systems have been tested and meet requirements.

B. Do not install until building is closed in.

C. Heavy work which may damage insulation shall have been completed in the vicinity of the insulation work.

D. All installations shall be made by skilled craftsmen regularly engaged in this type of work.

E. Insulation shall be continuous thru-wall, ceiling and floors.

F. Pipe and equipment to be clean and dry prior to insulating.

G. Install all insulation in strict conformance with manufacturer's instructions.

H. Where "Barrier-free" lavatory supplies and waste are covered with a protective covering or insulation, the insulation must be installed back to wall, flush with wall escutcheon. Escutcheon to be finished flush with wall and wall opening to be smaller than escutcheon plate through entire building.

I. All electrical heat tracing installations shall be coordinated with the electrical contractor. No insulation shall be installed until the heat trace wiring is completely installed, tested and approved. All insulation materials and installation work shall be the responsibility of the Insulation Contractor.

J. Install pipe insulation by slitting tubular sections and applying onto piping or tubing. Alternately, whenever possible, slide unslit sections oer the open ends of piping or tubing. All seams and butt joints shall be adhered and sealed using Armaflex 520 or 520 BLV Adhesive. If when using AP Armaflex SS, only the butt joints shall be adhered using Armaflex 520 or 520 BLV Adhesive, Armaflex HT 625 Adhesive shall be used with HT Armaflex.

K. Insulation shall be pushed onto the pipe, never pulled. Stretching of insulation may result in open seams and joints.

L. Tape the ends of the copper tubing before slipping the Armaflex insulation over the new pipes to prevent dust from entering the pipe.

M. All edges shall be clean cut. Rough or jagged edges of the insulation shall not be permitted. Proper tools such as sharp, non-serrated knives must be used.

N. On cold piping, insulation shall be adhered directly to the piping at the high end of the run using a two-inch strip of Armaflex 520 or 520 BLV Adhesive on the ID of the insulation and on the pipe. All exposed end cuts of the insulation shall be coated with Armaflex 520 or 520 BLV Adhesive. All penetrations through the insulation and termination points must be adhered to the substrate to prevent condensation migration.

O. Sheet insulation shall be used on all pipes larger than 6” IPS. Insulation shall not be stretched around the pipe. On pipes larger than 12” IPS, adhere insulation directly to the pipe on the lower 1/3 of the pipe.

P. Seams shall be staggered when applying multiple layers of insulation.

3.2 VALVES, FLANGES AND FITTINGS:

A. All fittings shall be insulated with the same insulation thickness as the adjacent piping. All seams and mitered joints shall be adhered with Armaflex 520 or 520 BLV Adhesive. Screwed fittings shall be sleeved and adhered with a minimum 1” overlap onto the adjacent insulation. Armaflex HT 625 Adhesive shall be used with HT Armaflex.

B. Valves, flanges, strainers and Victaulic couplings shall be insulated using Armaflex donuts that shall then be covered with sheet or oversized tubular insulation.

3.3 HANGERS

A. Support piping system using high density inserts with sufficient compressive strength. The pipe support insulation shall be elastomeric foam with the same or greater thickness than the pipe insulation. All joints shall be sealed with Armaflex 520 or 520 BLV adhesive.

B. Standard and split hangers: Piping supported by ring hangers shall have hangers insulated with the same insulation thickness as the adjacent pipe. All seams and butt joints shall be sealed with Armaflex 520 or 520 BLV Adhesive. Armaflex HT 625 Adhesive shall be used with HT Armaflex. Ring hangers may be sleeved using oversized tubular insulation. On cold piping, insulation shall extend up the hanger rod a distance equal to four times the insulation thickness. Insulation tape may be used to a thickness equal to the adjacent insulation thickness.

C. Clevis Hangers or other pipe support systems: Saddles shall be installed under all insulated lines at unistrut clamps, clevis hangers or locations where the insulation may be compressed due to the weight of the pipe. All piping shall have wooden dowels or blocks of a thickness equal to the insulation inserted and adhered to the insulation between the pipe and the saddle.

It is highly recommended for continuous insulation protection to use hanger sizes equal to the outer diameter of the pipe plus insulation thickness

D. Armafix IPH o Armafix NPH can be used to prevent compression of insulation at standard split, clevis hangers or other pipe support systems. To minimize the movement of Armafix, it is recommended that a pair of non-skid pads be adhered to the clamps. In addition, to prevent loosening of the clamps, use of an antivibratory fastener, such as a nylon-locking nut, is also recommended.

3.4 OUTDOORS EXPOSED PIPING

A. All outdoor exposed piping shall be painted with two coats of WB Armaflex Finish. Prior to applying the Finish, the insulation shall be wiped clean with denatured alcohol. The Finish shall not be tinted.

B. All outdoor exposed piping shall have the seams located on the lower half of the pipe.

3.5 EXTERIOR PIPE COVERING

A. Wrapping: Wrap insulation with embossed .016" aluminum jacket.

B. Fastenings: Cover shall be held in place with soft aluminum bands on 12" centers.

C. Valves and Fittings: Weatherproof all valves and fittings.

D. Finish: Apply two coats of vapor resistant mastic reinforced with glass fabric over wrapping.

3.6 PIPE COVERING (FOAMED PLASTIC TYPE)

A. All joints and seams shall be sealed with a compatible adhesive. Approved adhesives are as follows:

Armacel No. 520 (Low VOC use 520 BLV
Benjamin Foster Company No. 85-75 up to 200 degrees F.

Contractor may use self-sealing insulation in lieu of above.

B. Fitting covers shall be fabricated from the foamed plastic pipe insulation or from sheet insulation of the identical material. The fabrication shall be in accordance with manufacturer's instructions, and all seams mitered joints shall be joined using the adhesives described.

3.7 PIPE INSULATION – TYPES & THICKNESSES

A. Flexible Closed Cell:

Piping System	Up to 3"	Over 3" to 6"	Over 6"
Cold Water	½"	½"	¾"
Hot Water (120º)	1"	1"	1-1/2"
Hot Water Return (120º)	1"	1"	1-1/2"
Hot Water (140º)	1"	1"	1-1/2"
Hot Water Return (140º)	1"	1"	1-1/2"
Condensate Waste	½"	½"	-
Horizontal Storm (Primary)	½"	½"	¾"
Horizontal Storm (Secondary) -----Not Required-----			
Underside of Roof Drains	½"	½"	¾"
Branch Waste From EWC's	½"	---	---
Handicap Lav Waste & Water	½"	---	---
Soil/Waste Piping Above Ceiling	½"	½"	¾"

END OF SECTION 220030

SECTION 220110: DRAINAGE SYSTEMS - PLUMBING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this Section.

1.2 DESCRIPTION OF WORK

A. Refer to Section 220005 for a general description of the scope of work in this contract.

B. This section includes:

1. Soil and waste piping system work as indicated on drawings and schedules, and by requirements of this section.

2. Applications for soil and waste piping systems include the following:

a. Above ground soil, waste and vent piping within buildings including soil stacks, vent stacks, horizontal branches, traps and connections to fixtures and drains.

b. Underground building drain piping including mains, branches, traps, connections to fixtures and drains, and connections to stacks, extension from the building, terminating at connection to site sewer.

3. Storm water drainage piping as indicated on drawings and by requirements of this section.

4. Applications for storm water drainage piping include the following:

a. Roof drains and connections to gutters, with rain water conductors and connections to underground building storm drains.

b. Underground building storm drains, extending and connecting to site drainage system.

5. Insulation for soil and waste and storm water drainage as specified in Section 220030 is included as work of this section.

6. Trenching and backfilling required in conjunction with underground building drainage and site drainage piping as specified in Section 220000 is included as work of this section. Refer to Division I.

7. Installation of detectable metallic underground tape for <u>all</u> exterior buried PVC drainage piping.

1.3 REFERENCE STANDARDS

A. Refer to Section 220000 for a general description of requirements applying to this section.

1.4 QUALITY ASSURANCE

A. Refer to Section 220010 for a general description of requirements applying to this section, and a listing of all applicable codes.

1.5 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 220000.

B. Submit the following:

1. Product data on all systems equipment.

C. See requirements for submission of cross referencing information.

1.6 WARRANTY/GUARANTEE

A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, GENERAL REQUIREMENTS.

PART 2 PRODUCTS

2.1 PIPING UNDERGROUND

A. Interior:

1. Sanitary, storm water and condensate waste drainage piping within the building and extending beyond the building wall, unless otherwise noted on the plans shall be an option selection of a, b, or c below:

a. Service weight hub and spigot pattern cast iron soil pipe and fittings with neoprene gaskets.

b. Hubless cast iron soil pipe and fittings with cast iron coupling clamps and gaskets or heavy duty 3.04-.016" thick stainless steel bands..

c. PVC Schedule 40 pipe and fittings with solvent cement joints.

B. Exterior:

1. Stormwater drainage piping 10 inches and smaller, and all sanitary drainage piping unless otherwise noted on the plans, shall be:

a. Service weight hub and spigot pattern cast iron soil pipe and fittings, with neoprene gaskets.

b. Hubless cast iron soil pipe and fittings with cast iron coupling clamps and gaskets.

c. Unplasticized PVC sewer pipe and fittings SDR-35.

2. Stormwater drainage piping 12 inches and larger, shall be:

a. Reinforced concrete pipe and fittings.

b. Corrugated metal pipe.

c. As identified on the drawings.

3. Foundation drainage piping shall be:

a. Porous concrete pipe and fittings.

b. Perforated PVC pipe and fittings Schedule 40.

2.2 PIPING ABOVE GROUND (PLENUM RATED CEILING)

A. All above ground storm water, condensate, soil, waste and vent piping shall be:

1. Hubless cast iron soil pipe with cast iron drainage fittings, couplings and stainless steel clamp bands for piping 2" and larger.

2. Copper tubing, type DWV with wrought copper solder type drainage fitting for piping smaller than 2" in size.

3. PVC pipe and fittings type DWV with solvent cement joint connections.

2.3 CONDENSATE WASTE PIPING SYSTEM

A. All aboveground condensate waste piping including connection to equipment shall be:

1. PVC pipe and fittings type DWV with solvent cement joint connections.

2. Copper tubing, type DWV with wrought copper solder type drainage fittings.

2.5 FLASHING

A. All vents extending through the roof shall be flashed by the General Contractor. However, the Plumbing Contractor shall furnish and install the necessary counterflashing consisting of a Jay R. Smith Figure 1750 counterflashing fitting, or approved substitute as manufactured by Josam or Zurn. Vents shall terminate 18" above the roof.

2.6 SPECIAL EXPANSION COMPENSATION

A. Special expansion compensation products required for storm, condensate, soil and waste piping

systems include the following types:

B. Cast Iron Drainage System Expansion Joints: Cast-iron body, adjustable bronze sleeve, bronze bolts with wing nuts; for vertical installation only.

C. PVC Drainage System Expansion Joints: Factory prelubricated "O" ring expansion joint fitting. Installation must be in strict conformance with manufacturer's recommendations.

D. Available Manufacturers: Subject to compliance with requirements. Manufacturers offering expansion joints which may be incorporated in the work include:

1. Cast Iron Piping Systems - J.R. Smith or approved substitute.

2. PVC Piping Systems – George Fisher or approved substitute.

2.7 BACKWATER VALVES

A. Backwater valves (BWV) installed in the interior or exterior building sewer extension, shall be all PVC construction materials.

B. The backwater valve shall be in compliance with the latest edition of IPC and UPC Plumbing Codes.

C. Description:

1. The BWV shall be as manufactured by “Clean Check, Inc.”, P.O. Box 2437, Hayden, Idaho. Toll Free 1-866-288-2583.

2. The BWV shall be 3- and 4-inch diameter (76.2 and 101.6 mm) polyvinylchloride (VC) backwater valves, model numbers EBV-P301 and EBV-P401, respectively, satisfy the performance requirements of CSA B181.1 and CSA B181.2. The factory kit consists of a valve body, disc, disc seat, and upper collar. The factory supplied plastic materials conform to ASTM D-1784, cell classification 12454-B and NSF 14.

3. Removal of the integral lifting device from a buried valve allows above-grade replacement of the disc assembly and reinstallation into the valve body. The integral lifting device is self-aligning, self-seating, and provided with an alignment indicator located within 12 inches (305 mm) of the upper access opening.

2.8 SYSTEMS EQUIPMENT

A. Refer to Plumbing Fixture and Equipment Schedule for type, number, size and manufacturer of all drainage equipment and accessories.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering drainage equipment which may be incorporated in the work are limited to the following:

Floor Drains (all types)

Zurn
Josam
Wade
Watts
Smith

Roof Drains

Zurn
Josam
Wade
Watts
Smith

Cleanouts

Zurn
Josam
Wade
Watts
Smith

Downspout Shoes

Neenah
Zurn
Josam
Wade
Smith
Watts
MIFAB

Interceptors

Zurn
Josam
Wade
Watts
Smith
Woodford

Backwater Valves & Traps (Cast Iron)

Zurn
Josam
Wade
Watts

Smith
Red Valve Co.
MIFAB

Backwater Valve (PVC)

Clean Check, Inc.

Wall Spout Nozzles

Zurn
Josam
Wade
Watts
Smith

C. Cross Reference Identification:

1. If the Contractor selects a manufacturer of drainage equipment products other than as identified on the Schedule but is selected from the available manufacturers listed above, a cover sheet shall be included with the submission of shop drawings indicating the cross referenced manufacturer and model number.

2. Shop drawings shall not be reviewed or accepted if not in compliance with this requirement.

PART 3 EXECUTION

3.1 INSTALLATION OF SOIL AND WASTE PIPING

A. The Plumbing Contractor shall install a complete system of sanitary drainage piping as shown on the drawings. All drainage lines shall be properly run, trapped and vented in accordance with the local Plumbing Code and all dry vents, back vents, loop vents, revents or special vents required by the Code shall be furnished and installed by the Plumbing Contractor.

B. Drainage lines of the sizes shown on the drawings shall be extended within the building with branches connecting to the base of all soil, waste and vent stack, etc., leaving outlets for connection to all fixtures, floor drains, as required.

C. All changes in direction of drainage piping shall be installed with "Y" branches and 1/8 bends. All stacks shall be supported with concealed pipe clamps or hangers as required and the openings in the roof for the vent pipes will be provided by this Contractor.

D. All drainage piping which will be located above suspended ceilings shall be checked for slope to assure positive drainage, prior to installation of the ceilings. Pressure tests for leaks, as hereinafter specified, shall also be performed prior to ceiling installation.

E. Install soil and vent piping pitched to drain at minimum slope of 1/4" per foot (2%) for piping 3" and

smaller, and 1/8" per foot (1%) for piping 4" and larger.

F. Vertical to horizontal change in direction to be made with long radius fittings.

G. Support all soil and waste piping per IPC Section 308.5, 308.6 and 308.7.

3.2 INSTALLATION OF STORM WATER DRAINAGE PIPING

A. Connect piping to roof drains and outlets provided in gutters, install rainwater conductors and extend to underground storm building drains as indicated.

B. Underground storm building drains shall be extended from the building, terminating beyond the building wall.

C. Provide exterior clean-out on both sanitary and storm drain mains. Minimum size shall be 4” installed within 5 ft. of the building. (Also see Paragraph 3.5).

D. Connect to exterior downspouts, install cast iron downspout shoes, and extend piping from the building wall.

E. All changes in direction of drainage piping shall be installed with "Y" branches and 1/8 bends. All stacks shall be supported with concealed pipe clamps or hangers as required, and the openings in the roof for the vent pipes will be provided by this Contractor.

F. All drainage piping which will be located above suspended ceilings shall be checked for slope to assure positive drainage, prior to installation of the ceilings. Pressure tests for leaks, as hereinafter specified, shall also be performed prior to ceiling installation.

G. Install storm water drainage piping pitched to drain at minimum slope of 1/8" per foot (1%) for piping 4" and larger.

H. Vertical to horizontal change in direction to be made with long radius fittings.

3.3 INSTALLATION OF CLEANOUTS

A. Cleanouts: Install in sanitary piping and storm conductor and building drain piping as indicated, and/or as required by _____ Plumbing Code; at each change in direction of piping greater than 45 degrees; at minimum intervals of 100' for all size straight run piping; and at base of each conductor. Install floor and wall cleanout covers for concealed piping, select type to match adjacent building finish.

B. Exterior cleanouts shall be installed with access covers flush to grade. The cleanout shall be installed within a concrete pad, 18”x18”x6” thick.

3.4 INSTALLATION OF FLOOR DRAINS (ALL TYPES)

A. Install floor drains in accordance with manufacturer's written instructions and in locations indicated.

B. Install floor drains at low points of surface areas to be drained, or as indicated. Set tops of drains

flush with finished floor.

C. Install drain flashing collar or flange so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.

D. Position drains so that they are accessible and easy to maintain.

E. All floor drains shall be provided with trap primer connections. All floor drains shall have a trap primer discharge line connected to the outlet.

F. All exposed drainage piping shall be DWV copper pipe and fittings. All piping shall be rigidly supported off the wall with split ring clamps or uni-strut.

3.5 INSTALLATION OF ROOF DRAINS

A. Install drains in accordance with manufacturer's written instruction and in location indicated.

B. Coordinate with roofing as necessary to interface roof drains with roofing work.

C. Install drains at low points of surface areas to be drained, or as indicated.

D. Install drain flashing collar or flange so that no leakage occurs between drain and adjoining roofing. Maintain integrity of waterproof membranes, where penetrated.

E. Position drains so that they are accessible and easy to maintain.

F. The roof drain specified is a combination “Primary and Secondary” arrangement. Verify the correct outlet connections to their respective systems.

3.6 INSTALLATION OF DOWNSPOUT SHOES

A. Install downspout shoes in accordance with manufacturer's written instructions and in locations indicated.

B. Downspout shoes shall be installed with top of shoe located 18 inches above finished grade.

C. Provide trap in drain connection from each downspout.

3.7 INSTALLATION OF BACKWATER VALVES

A. A threaded plug, female adaptor and 6-inch diameter (152.4 mm) pipe shall be supplied by others for use as the access sleeve and cover. The access sleeve shall be cut to length in the field and attached to the socket on the top of the valve body. This forms the housing for the removable integral lifting device. The integral lifting device consists, in part, of a 4-inch diameter (101.6 mm) pipe which is supplied by others. The 4-inch diameter (101.6 mm) pipe is cut to length in the field, then joined to the disc assembly on the bottom and the collar on the top.

B. The manufacturer’s published installation instructions shall be strictly adhered to and, if requested by the code official, a copy shall be maintained on the job site during installation. A copy of the

maintenance instructions shall be left with the Owner.

3.8 INSTALLATION OF INTERCEPTORS

A. Install interceptors in accordance with manufacturer's written instruction and in location indicated.

B. Install flow control fitting where indicated on the drawing and/or diagrams including vent relief piping.

C. Interceptors shall be vented in accordance with the local plumbing code and as indicated on the drawings.

3.9 INSTALLATION OF FOUNDATION DRAINAGE

A. Each section of foundation drainage piping shall be extended up, to a cleanout at grade. Piping shall pitch toward the connection to the stormwater drainage system.

B. Piping shall be laid on minimum of 6 inches No. 8 aggregate crushed stone, and backfill shall be done as detailed on the drawings. Crushed stone shall be washed. Aggregate shall be of the sizes indicated and in accordance with ASTM standards. Stone fill layer shall be carefully placed to the indicated
depth without disturbing the pipe alignment and a layer of untreated building paper or 2 inches of salt hay placed on top of the stone, the full width of the trench. Remaining earth fill shall be mounded at top to allow for settlement.

3.10 UNDERGROUND METALLIC TAPE

A. All exterior underground PVC drainage piping (sanitary, storm, condensate waste) shall be provided with detectable metallic underground tape.

B. Tape shall be similar to Lineguard Maintenance Systems as provided by Utility Supply of America 800-548-1234 or approved substitute as manufactured by Seton.

C. Installation shall comply with manufacturer’s recommendations and shall be installed in the backfill after refilling the trench opening completely, and allowed to settle to the desired 4” to 6” depth. The Contractor shall install the tape after final lifts in compaction backfilling or unroll it before final restoration or installation of sod, black dirt, seeding, etc.

D. The tape system shall be installed under the supervision of the Owner’s Representative. When the tape system is complete, the Contractor shall provide a test using the tape manufacturer’s recommended detection device, to prove the integrity of the installation with the Owner’s Representative.

3.11 INSPECTION

A. The Plumbing Contractor shall, upon completion of the drainage systems, secure from the Inspector and/or the Municipality under which the installation was made and inspected, certificates or letters of approval indicating the system has been installed satisfactorily. The Plumbing Contractor shall certify that all inspection fees, permits and charges have been duly paid.

END OF SECTION 220110

SECTION 220120: DOMESTIC WATER SYSTEMS - PLUMBING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this Section.

1.2 DESCRIPTION OF WORK

A. Refer to Section 220005 for a general description of the scope of work in this contract.

B. This Section includes:

1. Domestic water piping systems work is indicated on drawings and schedules and by requirements of this section.

C. Applications for water piping systems include the following:

1. Exterior water service piping from connection 5'-0" beyond building foundation to building domestic water piping.

2. Exterior domestic water meter and pit installation.

3. Domestic cold-water piping.

4. Domestic hot-water piping.

5. Domestic recirculating-water piping.

D. Complete flow balancing of the entire domestic hot water return system.

E. Insulation for domestic water piping as specified in Section 220030 is included as work of this section.

F. Trenching and backfill required in conjunction with exterior water piping as specified in Section 220000 is included as work of this section. Refer to Division 1.

1.3 REFERENCE STANDARDS

A. Refer to Section 220000 for a general description of requirements applying to this section.

1.4 QUALITY ASSURANCE

A. Refer to Section 220010 for a general description of requirements applying to this section.

1.5 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 220000.

B. Submit the following:

1. Product data on all specialties and systems equipment.

1.6 WARRANTY/GUARANTEE

A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, GENERAL REQUIREMENTS.

PART 2 PRODUCTS

2.1 DOMESTIC WATER PIPING MATERIALS AND PRODUCTS

A. Provide piping materials and factory fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in domestic water piping systems. Where more than 1 type of materials or products are indicated, selection is Installer's option.

2.2 BASIC PIPE, TUBE AND FITTINGS

A. Provide pipe, tube, and fittings complying with Division 22 Basic Materials and Methods section "Pipe, Tube, and Fittings", in accordance with the following listing:

B. Interior Domestic Water Piping:

Tube Size 4" and Smaller:	Copper tube.
Wall Thickness:	Type "L" hard-drawn temper.
Fittings:	Wrought-copper, solder-joints.

C. Exterior Water Service Piping:

Pipe Size 3" and Smaller:	Copper tube.
Wall Thickness:	Type "K" Soft Temper
Fittings:	Wrought copper solder joint.
Pipe Size 4" and Over:	Ductile-iron pipe with cement-mortar lining, and gasketed joints.
Pipe Weight:	Schedule 150.

Fittings:	Ductile-iron, with cement-mortar lining, mechanical joint.
Pipe Size 3" and Smaller:	Polyvinyl Chloride (PVC) ASTM 1785
Wall Thickness:	Schedule 80.
Fittings:	PVC with Schedule 80, socket-type solvent joints or elastomeric gasketed joints.
Pipe Size 4" to 12":	Polyvinyl Chloride (PVC) AWWA C900
Pipe Class:	Class 200
Fittings:	Ductile iron complying with AWWA C110 cement lined with rubber gaskets conforming to AWWA C111

2.3 BASIC PIPING SPECIALTIES

A. Provide piping specialties complying with Section 220010 Basic Materials and Methods in accordance with the following listing:

Pipe escutcheons
Dielectric unions
Drip pans
Pipe sleeves
Sleeve seals

2.4 SPECIAL PIPING SPECIALTIES

A. Water Hammer Arresters: Provide bellows or piston type water hammer arresters, pressure rated for 250 psi, tested and certified in accordance with PDI Standard WH-201.

2.5 BASIC VALVES

A. Provide valves complying with applicable Division 22 sections "Valves", in accordance with the following listing:

B. Sectional Valves:

2-1/2" and Smaller:	Ball Valves. Gate Valves.

3” and Larger:	Ball Valves. Butterfly Valves.

C. Shutoff Valves:

2-1/2" and Smaller:	Ball Valves. Gate Valves
3" and Larger:	BallValves. Butterfly Valves.

D. Drain Valves:

All	Hose End Threaded Gate or Ball Valves.

E. Balancing Valves:

2" and Smaller:	Ball Valves (Circuit Setter Type). (with Memory Stop)

F. Check Valves:

All Sizes:	Swing Check Valves. Horizontal Installations Spring Check Valves. Vertical Installations

2.6 SPECIAL VALVES

A. Special valves required for domestic water piping systems include the following types:

B. Hose Bibbs: Threaded end, renewable composition disc, tee handle, 3/4" NPT inlet, 3/4" hose outlet with vacuum breaker.

1. Finished Areas: Chrome plated.
2. Unfinished Areas: Bronze finish.

C. Wall Hydrants: Non-freeze, cast-bronze body, tee handle key, bronze casing, length to suit wall thickness, vacuum breaker, hinged locking cover, 3/4" inlet, hose outlet.

D. Lawn Boxes: Non-freeze, bronze ground hydrant with locking cover, rough bronze box, vacuum breaker, 1 inch connection, and suitable for 4'-0" depth of bury.

2.7 BASIC THERMOMETERS AND GAUGES

A. Provide thermometers and gauges complying with Division 22 Basic Materials and Methods Section "Meters and Gauges", in accordance with the following listing:

Pressure gauges
Glass thermometers

Pressure and temperature connections

2.8 BASIC PUMPS

A. Provide pumps as specified in applicable Section 220150 Equipment - Plumbing. Use inline pumps for hot water recirculating.

2.9 BACKFLOW PREVENTERS

A. Provide, of the type indicated on the drawing schedule, reduced pressure principal type, blackflow preventers shall consist of an assembly including shutoff valves on inlet and outlet, and strainer on inlet. Backflow preventers shall include test cocks, and pressure-differential relief valve located between two positive seating check valves. Construct in accordance with ASSE Standard.

B. On dead-end services (HVAC make-up) provide a spring-loaded check valve ahead of the backflow preventer assembly.

2.10 SYSTEMS EQUIPMENT MANUFACTURERS

A. Refer to Plumbing Fixture and Equipment Schedule for type, number, size and manufacturer of all equipment and accessories.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering equipment which may be incorporated in the work are limited to the following:

Shock Absorbers:

Zurn
Josam
Wade
Watts
Smith
PPP Inc.

Automatic Trap Primers

PPP Inc.
Sloan
Sioux Chief

Hose Bibbs

Nibco
Tanner
Central Brass
Wolverine

Wall Hydrants

Nibco
Tanner
Central Brass
Wolverine

Wall Hydrants

Zurn
Josam
Wade
Watts
Smith
Woodford

Lawn Boxes

Zurn
Josam
Wade
Watts
Smith
Woodford

Backflow Preventers

Conbraco
Neptune
Watts

Relief Valves

Rockwell
Fisher
DeZurik

Pressure Reducing Valves

Conbraco
Jamesbury
DeZurik
Fisher
ITT Bell & Gossett

PART 3 EXECUTION

3.1 INSTALLATION OF BASIC IDENTIFICATION

A. Install mechanical identification in accordance with Section 220010 Basic Materials and Methods.

B. Support vertical piping at floor levels using approved riser clamps. Clamp material shall be compatible with pipe material. Maximum vertical spacing shall be 10'-0". Domestic water piping shall be supported in accordance with the International Mechanical Code, Section 305 and Table 305.4 Spacing Intervals, or in accordance with MSS-SP-69. International Plumbing Code's latest edition, Section 308.5, accept as follows:

1. Copper tubing ½" to 1-1/4" nominal size, not to exceed 6 ft. horizontal intervals.
2. Copper tubing 1-1/2" and larger nominal size, not to exceed 10 ft. horizontal intervals.
3. Copper tubing ½" to 1-1/4" nominal size, not to exceed 10 ft. vertical intervals.
4. Copper tubing 1-1/2" and larger nominal size not to exceed 10 ft. vertical intervals.
5. CPVC pipe or tubing ¼" to 1" nominal size, not to exceed 3 ft. horizontal spacing.
6. CPVC pipe or tubing 1-1/4" and larger nominal size not to exceed 4 ft. horizontal spacing.
7. CPVC pipe or tubing ¼" to 1" nominal size not to exceed 10 ft. vertical.
8. CPVC pipe or tubing 1-1/4" and larger nominal size not to exceed 10 ft. vertical."

*Mid-Story Guide.

3.2 INSTALLATION OF DOMESTIC WATER SERVICE SYSTEM - BUILDING

A. Install water distribution system in accordance with Section 220010 Basic Materials and Methods, and the International Mechanical Codes Section 305, and Support Intervals under Tables 305.4 and 308.5 or in accordance with MSS-SP-69.

3.3 INSTALLATION OF PIPING SPECIALTIES

A. Install piping specialties in accordance with Section 220010 Basic Materials and Methods.

B. Water Hammer Arresters: Install in upright position, in locations and of sizes in accordance with PDI Standard WH-201, and elsewhere as indicated.

3.4 INSTALLATION OF VALVES

A. Install valves in accordance with Division 22 Basic Materials and Methods section, "Valves".

B. Sectional Valves: Install on each branch and riser, close to main, where branch or riser serves 2 or more fixtures, equipment connections, and elsewhere as indicated.

C. Shutoff Valves: Install on inlet of each plumbing equipment item, and on inlet of each plumbing fixture, and elsewhere as indicated.

D. Drain Valves: Install on each plumbing equipment item located to completely drain equipment for service or repair. Install at base of each riser, at base of each rise or drop in piping system, and elsewhere where indicated or required to completely drain domestic water piping system.

E. Check Valves: Install on discharge side of each pump, and elsewhere as indicated.

F. Balance Cocks: Install in main recirculating loop and in each branch hot water recirculating loop.

Install a ball valve and check valve at each balance valve installation.

G. Hose Bibbs: Install on exposed piping where indicated, with vacuum breaker.

3.5 INSTALLATION OF BACKFLOW PREVENTERS

A. Install backflow preventers where indicated, and where required by International Plumbing Code. Locate in same room or area as equipment being protected.

B. RPZ type backflow preventers to be piped from the relief outlet to nearest floor drain.

C. A check valve is required on the upstream side of all RPZ installations.

3.6 INSTALLATION OF PRESSURE REGULATING VALVES

A. Install pressure regulating valves where indicated. Provide inlet and outlet shutoff valves, and ball valve bypass. Provide pressure gauge on valve outlet.

3.7 INSTALLATION OF EXPANSION COMPENSATION PRODUCTS

A. This project shall require the installation of expansion compensators.

B. Furnish and install expansion compensation products in accordance with Section 220210 Basic Materials and Methods – HVAC

3.8 INSTALLATION OF THERMOMETERS AND GAUGES

A. Install thermometers and gauges in accordance with Section 220010 Basic Materials and Methods.

3.9 INSTALLATION OF WATER METER

A. Install water meter in accordance with Section 220010 Basic Materials and Methods.

B. Meter shall be supported in accordance with the requirements of the Water Department.

3.10 EQUIPMENT CONNECTIONS

A. Piping Runouts to Fixtures: Provide hot and cold water piping runouts to fixtures of sizes indicated, but in no case smaller than required by International Plumbing Code.

B. Equipment furnished by the Owner or Contractors other than this Contractor: After equipment has been set in place, this Contractor shall furnish all labor and material required to make final connections, between roughing-in and the equipment. Install valves, fittings, trim and appurtenances furnished with the equipment. All exposed piping in the kitchen areas shall be chrome plated. Piping in other areas shall be of the same material as the system to which it connects.

3.11 AUTOMATIC TRAP PRIMERS

A. Install units in accordance with manufacturer's written instructions.

B. Cap-off all unused tube connections not to be used for discharge procedures.

C. Units installed in Mechanical Room shall be surface mounted. All others shall be arranged for recessed installation and shall include a 14"x16" access door #D-1416SS.

D. All discharge tubing from the tube connectors to the floor drain connection shall be minimum Type "M" copper for above floor slab installations. Where discharge piping runs below the floor slab, the piping may be PVC grade water piping. Ensure that all connections are properly made and leak-free.

E. Verify all electrical connections prior to the start-up of the units.

F. Shield copper from direct contact with concrete, stone and sharp edges below slab.

3.12 SPARE PARTS

A. Furnish to Owner, with receipt, one valve key for each key operated hydrant, bibb, or faucet installed.

3.13 INSTALLATION OF EXTERIOR WATER PIPING (5'-0" EXTENSIONS)

A. Install exterior water service piping system in compliance with local governing regulations.

B. Main Connections: Coordinate all work with the Site Contractor. The Plumbing Contractor shall make final connections of the domestic and fire protection water services.

C. Water Service Piping: From the final connection points, extend water service piping of size and in locations indicated to the water service entrance in building. Provide ball valve at the domestic water service and a flanged connection with a ¾” blow-off valve for the fire protection water service (12" A.F.F.).

D. Ductile-Iron Pipe: Install in accordance with ANSI/AWWA C-60.

E. Test:

1. Domestic Water Service: Minimum 125 psi.
2. Fire Protection Water Service: Minimum 200 psi.
3. Combination Domestic & Fire Protection Water Service: Minimum 200 psi.

F. Sterilization: At completion of water service line installation, flush and sterilize in conformance with AWWA C-601, to satisfaction of local Authorities Having Jurisdiction.

3.14 DOMESTIC HOT WATER RETURN

A. This Contractor shall install complete and operating hot water return system. The system shall be balanced and include a report as required in HVAC Specification Section 220950.

B. Balancing Valves are required in the system as hereinbefore specified. The system shall also include the installation of “air bleed” or “burp” valves to remove any trapped air in the system.

C. Where emergency showers are installed with thermostatic mixing valve, they shall require the

installation of a hot water return line as detailed on the drawings.

END OF SECTION 220120

SECTION 220130: GAS PIPING SYSTEMS - PLUMBING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this Section.

1.2 DESCRIPTION OF WORK

A. Refer to Section 220005 for a general description of the scope of work in this contract.

B. This Section includes:

1. Natural gas piping system as indicated on drawings and schedules, and by requirements of this section.

2. Applications for natural gas piping systems include the following:

   a. Gas service from street main to building meter by Delmarva Gas Division.

   b. Elevated pressure (psi) gas from meter location to rooftop gas-fired equipment.

   c. Low pressure (WC) from the meter location to all other equipment and outlets, requiring gas service.

3. Applications for propane gas piping systems include the following:

   a. All gas piping from the exterior secondary regulator assembly location to all equipment and outlets, requiring gas service.

4. Trenching and backfill required in conjunction with exterior gas distribution as specified in Section 220000 is included as work of this section. Refer to Division 1.

1.3 REFERENCE STANDARDS

A. Refer to Section 220000 for a general description of requirements applying to this Section.

1.4 QUALITY ASSURANCE

A. Refer to Section 220010 for a general description of requirements applying to this section.

1.5 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 220000.
B. Submit the following:
   1. Product data on gas valves.

1.6 WARRANTY/GUARANTEE

A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, GENERAL REQUIREMENTS.

PART 2 PRODUCTS

2.1 NATURAL GAS PIPING MATERIALS AND PRODUCTS

A. Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide materials and products complying with ANSI B31.2 where applicable, base pressure rating on natural gas piping system maximum design pressures. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match piping materials used in natural gas piping systems. Where more than 1 type of material or product is indicated, selection is Installer's option.

2.2 BASIC IDENTIFICATION

A. Provide identification complying with Division 22 Sections and in accordance with the following listing:

Building Distribution Piping: Plastic pipe markers.

Gas Service: Underground type plastic line markers.

Gas Valves: Plastic valve tags.

2.3 BASIC PIPE, TUBE AND FITTINGS

A. Provide pipe, tube and fittings complying with Section 220010 Basic Materials and Methods - Plumbing and in accordance with the following listing:

1. Interior Piping: Schedule 40 black steel ASTM A-53, A-106

   Fittings: Malleable black iron, threaded (NCC)

2. Exterior Exposed or Roof Top Piping: Schedule 40 black steel with weather coating.

   Fittings: Wrought steel, butt welded.

2.4 BASIC PIPING SPECIALTIES

A. Provide piping specialties complying with applicable Division 22 Sections and in accordance with the following listing:

Pipe escutcheons
Pipe sleeves

Sleeve seals

2.5 SPECIAL VALVES

A. Valves required for gas piping systems on this project shall be the following types:

Gas Valves: (Up to 3")

1. Apollo 80-100 Series bronze gas ball valve. Threaded, 600 PSIG WOG, cold non-shock. 250 PSIG LP-Gas. 150 PSIG saturated steam. Vacuum service to 29 inches Hg. Federal Specification: WW-V-35C, Type: II, Composition: BZ, Style: 3.

2. Features:

   - UL Listed for LP-Gas and natural gas.
   - Large ports to reduce pressure drop
   - Reinforced TFE seats and seals
   - Blow-out-proof stem design
   - Optional tee handle available
   - Quarter turn on-off
   - Adjustable packing gland
   - One piece bronze body
   - Chromium plated ball

3. UL Listings:

   - Guide YSDT: LP-Gas shut-off valve.
   - Guide YRPV: Gas shut-off valve for use with natural and manufactured gases.

4. This valve shall be used for all pipe sizes up to 3" in the system.

B. Manufacturers: Subject to compliance with requirements, provide gas valves of one of the following:

Apollo/Conbraco
Stockham
Milwaukee
NIBCO, Inc.
Watts

2.6 GAS METER

2.7 GAS PRESSURE REGULATORS

A. ANSI Z21.18, single-stage, steel-jacketed, corrosion-resistant pressure regulators. Include atmospheric vent, elevation compensator, with threaded ends conforming to ASME B1.20.1 for 2 inch NPS and smaller and flanged ends for 2-1/2" NPS and larger. Regulator pressure ratings, inlet and outlet pressures, and flow volume in cubic feet per hour of natural gas at specific gravity are as indicated.

1. Service Pressure Regulators: Inlet pressure rating not less than natural gas distribution system service pressure.

2. Line Gas Pressure Regulators: Inlet pressure rating not less than system pressure.

3. Appliance Gas Pressure Regulators: Inlet pressure rating not less than system pressure.

4. Gas Pressure Regulator Vents: Factory or field installed corrosion-resistant screen in opening when not connected to vent piping.

5. Regulators shall be as manufactured by Fisher (no equal substitute permitted).

PART 3 EXECUTION

3.1 INSTALLATION OF BASIC IDENTIFICATION

A. Install mechanical identification in accordance with applicable Division 22 Sections.

3.2 INSTALLATION OF NATURAL GAS PIPING (INTERIOR)

A. Install natural gas distribution piping in accordance with Section 220010 Basic Materials and Methods - Plumbing and in accordance with applicable codes IFGC latest edition, and local Utility Company requirements.

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

C. Remove cutting and threading burrs before assembling piping.

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

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

F. Install drip-legs in gas piping where indicated, and where required by code or regulation.

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

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

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

J. Install piping parallel to other piping, but maintain minimum of 12" clearance between gas piping and steam or hot water piping above 200 degrees F (93 degrees C).

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

L. Gas valves shall not be installed above ceilings without access and signage.

M. Supports:

1. All pipe, fittings, valves, installation and testing shall be in accordance with the IFGC, Chapter 4.

2. Gas piping shall be supported in accordance with the International Fuel Gas Code's latest accepted 2003 Edition, Section 407, as follows:

3. Support intervals shall be in accordance with the IFGC listed above and in Section 415, Table 415.1 as follows:

   a. Steel pipe ½" nominal size – not to exceed 6 ft.
   b. Steel pipe ¾" to 1" nominal size – not to exceed 8 ft.
   c. Steel pipe 1-1/4" and larger nominal size horizontal – not to exceed 10 ft.
   d. Steel pipe 1-1/4" and larger nominal size, vertical not to exceed every floor.

4. Support and spacing of CSST Systems shall be in accordance with CSST manufacturer's instructions.

3.3 GAS SERVICE

A. Arrange and coordinate with Utility Company to provide gas service and meter at indicated location with shutoff at terminus. Consult with Utility as to extent of its work, costs, fees and permits involved. Pay such costs and fees; obtain permits.

B. Extend service pipe from Utility's terminus to distribution piping, in compliance with Utility's requirements.

3.4 INSTALLATION OF VALVES

A. Gas valves: Provide at connection to gas train for each gas-fired equipment item; and on risers and branches where indicated.

B. Locate gas valves where easily accessible, and where protected from possible damage.

3.5 EQUIPMENT CONNECTIONS

A. Connect gas piping to each gas-fired equipment item, with drip leg, union and shutoff gas valve. Comply with equipment manufacturer's instructions. Drip legs shall **not** be installed on any exterior gas piping.

B. Equipment furnished by the Owner, or Contractors other than this Contractor: After equipment has been set in place, this Contractor shall furnish all labor and material required to make final connections between roughing-in and the equipment. Install valves, fittings, trim and appurtenances furnished with the equipment. Piping shall be of the same material as the system to which it connects.

3.6 INSTALLATION OF GAS PRESSURE REGULATORS

A. This Contractor shall furnish and install gas pressure regulating valves for all shown on the drawings. Installation shall be in strict accordance with the requirements of the Utility Company and the Canadian Gas Association.

B. All regulators installed shall be tagged with data noting the inlet and outlet pressure for each individual regulator installed.

C. Medium or High Pressure (MP) (HP) Regulators shall comply with the following:

1. The MP regulator shall be approved and shall be suitable for the inlet and outlet gas pressures for the application.

2. The MP regulator shall maintain a reduced outlet pressure under lockup (no flow) conditions.

3. The capacity of the MP regulator, determined by published ratings of its manufacturer, shall be adequate to supply the appliances served.

4. The MP pressure regulator shall be provided with access. Where located indoors, the regulator shall be vented to the outdoors or shall be equipped with a leak-limiting device, in either case complying with Section 410 of the IFGC.

5. A tee fitting with one opening capped or plugged shall be installed between the MP regulator and its upstream shutoff valve. Such tee fitting shall be positioned to allow connection of a pressure-measuring instrument and to serve as a sediment trap.

6. A tee fitting with one opening capped or plugged shall be installed not less than 10 pipe diameters downstream of the MP regulator outlet. Such tee fitting shall be positioned to allow connection of a pressure-measuring instrument.

3.7 EXTERIOR GAS PIPING

A. All rooftop or exterior gas piping shall be weatherproof with and epoxy resin approved by the Gas Company.

B. Uncoated, threaded or socket welded joints shall not be used in piping in contact with soil or where internal or external service corrosion is known to occur.

C. Protective Coatings and Wrapping: Pipe protective coatings and wrappings shall be approved for the application and shall be factory applied.

END OF SECTION 220130

SECTION 220140: FIXTURES - PLUMBING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the Work specified in this Section.

1.2 DESCRIPTION OF WORK

A. Refer to Section 220005 for a general description of the scope of work in this contract.

B. This Section includes:

1. Plumbing fixtures and trim work as indicated by drawings and schedules, and by requirements of this section.

2. Types of plumbing fixtures required for the project include the following:

   Water Closets
   Urinals
   Lavatories
   Countertop Sinks
   Service Sinks
   Mop Receptors
   Electric Water Coolers
   Sensor-Operated Flush Valves and Faucets
   Manually Operated Flush Valves
   Handicap Lavatory Insulation
   Lavatory Shield Enclosure

3. Refer to Section 220120 for domestic water piping systems used in conjunction with plumbing fixtures; not work of this section.

4. Refer to Section 220110 for soil and waste piping systems used in conjunction with plumbing fixtures; not work of this section.

5. Refer to Division 26 sections for electrical connections to water coolers and other plumbing fixtures; not work of this section.

1.3 REFERENCE STANDARDS

A. Refer to Section 220000 for a general description of requirements applying to this section.

1.4 QUALITY ASSURANCE

A. Refer to Section 220010 for a general description of requirements applying to this section.

B. Manufacturers: Firms regularly engaged in manufacture of plumbing fixtures of the type, style and configuration required, whose products have been in satisfactory use in similar service for not less than 3 years.

C. Plumbing Fixture Standards: Comply with applicable portions of _____Plumbing Code pertaining to materials and installation of plumbing fixtures.

D. ANSI Standards: Comply with applicable ANSI standards pertaining to plumbing fixtures and systems.

E. ANSI & ADA Standards: Comply with ANSI A171.1 Standard and the ADA Standard pertaining to plumbing fixtures and provisions for handicapped.

1. Water closets shall measure 17" to 19" from the floor to the top of the seat. Bowls shall be elongated type.

2. Flush valve mechanisms shall be on the wide side of the stall, no higher than 44" above the floor.

3. Urinals shall be elongated (14" rim from the wall) mounted no higher than 17" from the floor.

4. Lavatories shall be mounted no higher than 34" from the floor and provide knee clearance using an offset drain assembly with "P" trap set parallel to the fixture supporting wall. Trap and wall supplies shall be installed for clearance required for the installation of lavatory shield enclosures.

5. Faucets shall be lever operated, push type, touch type, electronically operated. See Fixture Schedule. All faucets shall operate on less than 5 pounds force and shall not require tight grasping, pinching or twisting of the wrist.

F. PDI Compliance: Comply with standards established by Plumbing and Drainage Institute pertaining to plumbing fixture supports.

G. Federal Standards: Comply with applicable FS WW-P-541/- Series sections pertaining to plumbing fixtures.

H. UL Labels: Provide water coolers which have been listed and labeled by Underwriters' Laboratories.

I. ARI Labels: Provide water coolers which are rated and certified in accordance with applicable Air-Conditioning and Refrigeration Institute Standards.

1.5 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 220000.

B. Submit the following:

1. Product Data: Submit manufacturer's specifications for plumbing fixtures and trim, including catalog cut of each fixture type and trim item furnished, roughing-in dimensioned drawings, templates for cutting substrates, fixture carriers, and installation instructions.

2. Color Selection Data: Submit charts or samples for color selection where applicable.

3. Maintenance Data: Submit maintenance data and parts lists for each fixture type and trim item, including instructions for care of finishes. Include this data in maintenance manual.

1.6 WARRANTY/GUARANTEE

A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, GENERAL REQUIREMENTS.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver plumbing fixtures individually wrapped in factory-fabricated containers.

B. Handle plumbing fixtures carefully to prevent breakage, chipping and scoring the fixture finish. Do not install damaged plumbing fixtures; replace and return damaged units to equipment manufacturer.

PART 2 PRODUCTS

2.1 PLUMBING FIXTURES

A. Provide factory-fabricated fixtures of type, style and material indicated. For each type fixture, provide fixture manufacturer's standard trim, carrier, seats, and valves as indicated by their published product information; either as designed and constructed, or as recommended by the manufacturer and as required for a complete installation. Where more than one type is indicated, selection is Installer's option; but, all fixtures of same type must be furnished by single manufacturer. Where type is not otherwise indicated, provide fixtures complying with governing regulations.

2.2 MATERIALS

A. Unless otherwise specified, comply with applicable Federal Specification WW-P-541/-Series sections pertaining to plumbing fixtures, fittings, trim, metals and finishes. Comply with the requirements of WW-P-541/-specification relative to quality of ware, glazing, enamel, composition and finish of metals, air gaps, and vacuum breakers, even though some plumbing fixtures specified in this section are not described in WW-P-541/-.

B. Provide materials which have been selected for their surface flatness and smoothness. Exposed surfaces which exhibit pitting, seam marks, roller marks, foundry sand holes, stains, decoloration, or other surface imperfections on finished units are not acceptable.

C. Where fittings, trim and accessories are exposed or semi-exposed, provide bright chrome-plated or polished stainless steel units. Provide copper or brass where not exposed.

D. Stainless Steel Sheets: ANSI/ASTM A-167, Type 302/304, hardest workable temper. Finish: No. 4, bright, directional polish on exposed surfaces.

E. Steel Sheets for Baked Enamel Finish: ANSI/ASTM A-591, coating Class C, galvanized-bonderized.

F. Steel Sheets for Porcelain Enamel Finish: ANSI/ASTM A-424, commercial quality, Type 1.

G. Vitreous China: High quality, free from fire cracks, spots, blisters, pinholes, and specks; glaze exposed surfaces, and test for crazing resistance in accordance with ANSI/ASTM C-554.

H. Fiberglass: ANSI Z124 smooth surfaced, with color selected by Architect/Engineer.

I. Aluminum: ANSI/ASTM B-209/B-221 sheet, plate and extrusions, as indicated; alloy, temper and finish as determined by manufacturer, except 0.40 mil natural anodized finish on exposed work unless another finish is indicated.

J. Synthetic Stone: High quality free from defects, glaze on exposed surfaces, stain resistant.

2.3 PLUMBING FITTINGS, TRIM AND ACCESSORIES

A. Lavatory Protective Shield Covers:

1. Fully molded enclosure “Lav Shields” as manufactured by Zurn or Truebro, Inc., complete with tamper-resistant stainless steel fasteners.

2. Shield enclosure to meet A.D.A. #4.19.4, ANSI A117.1 and BOCA P- 1203.4.

B. Water Outlets: At locations where water is supplied (by manual, automatic or remote control), provide commercial quality faucets, valves, or dispensing devices, of type and size indicated, and as required to operate as indicated. Include manual shutoff valves and connecting system pipes to permit outlet servicing without shut- down of water supply piping systems.

1. Vacuum Breakers: Provide with flush valves where required by governing regulations, including locations where water outlets are equipped for hose attachment.

C. P-traps: Include removable P-traps where drains are indicated for direct connection to drainage system. All traps shall be minimum 17 gauge.

D. Carriers: Provide cast-iron and/or steel supports for fixtures. Carriers shall be provided for all wall-hung fixtures, and/or the carrier shall be selected to support the fixture independently of the wall. Carriers shall be adjustable type, complete with all fittings and foot supports. Carrier shall be single or double, back-to-back, horizontal offset and vertical stack type. Carrier shall be selected and used as best suited within the pipe chases. Where noted or indicated, stud mount type carriers shall be used and installed within stud wall s 8” and less.

E. Fixture Bolt Caps: Provide manufacturer's standard exposed fixture bolt caps finished to match fixture finish.

F. Escutcheons: Where fixture supplies and drains penetrate walls in exposed locations, provide chrome plated sheet steel escutcheons with friction clips.

G. Aerators: Provide aerators of types approved by Health Departments having jurisdiction.

H. Comply with additional fixture requirements contained in fixture schedule attached to this section.

2.4 FIXTURE LIST

A. Refer to the "Plumbing Fixture & Equipment Schedule" as indicated on the drawings.

2.5 SENSOR-OPERATED FLUSH VALVES & FAUCETS

A. This Contractor shall furnish and install complete and operating sensor operational faucets and flush valves where so indicated and noted. This shall include, but not be limited to, transformers and low voltage wiring.

B. Electrical power wiring shall be provided at the pipe chases and lavatory wash stations as required by the Electrical Contractor. See Electrical Plans. All wiring beyond that point shall be considered control wiring and shall be the complete responsibility of the Plumbing Contractor.

C. The Contractor shall have a complete understanding of the sensor operated equipment and system they are installing during the bid phase of the work. This includes all control wiring for the operation and function of the flush valves and faucets.

D. The Contractor shall install the system in strict conformance with the manufacturer's written instructions. The installation shall be executed with good workmanship and to be clear of any interference with the user including the installation of lavatory protective shield enclosures.

E. All faucet installations shall require a mixing valve for single water supply to faucet.

F. All sensor wall-mounted boxes and/or panels, including setting heights, shall be strictly coordinated with the masonry contractor for both drywall and block wall installations.

G. Flush valve electrical box positioning and support kits shall be provided wherever drywall partitions are installed. The kit shall be specifically designed to accurately position and ease the installation of the electrical box and the plumbing rough-in piping and valve. The kit shall be supplied by the flush valve manufacturer and installed by the Plumbing Contractor.

H. The manufacturer's representative shall have at least two (2) site visits to verify that equipment and wiring are properly installed.

I. The Contractor shall coordinate the location of the electrical power junction box with Electrical Contractor including the installation of the transformer unit. The Plumbing Contractor shall provide an adequate sized access panel for maintenance and servicing of the transformer and junction box. The Contractor shall locate the junction box and transformer where best suited either above the ceiling or pipe chase wall.

2.6 HANDICAP LAVATORY INSULATION

A. Fully molded "P" trap and angle valve insulation kit Handi-Lav Guard Truebro Model #101, 102 and

105 to suit.

B. Insulation to meet A.D.A. #4.19.4, ANSI A117.1 and BOCA P- 1203.4.

C. Self-extinguishing ASTM D635 burn characteristics, Thermal conductivity ASTM C177-K value 1.17.

PART 3 EXECUTION

3.1 FIXTURE CONNECTIONS

A. Connections to plumbing fixtures shall be of the sizes indicated on the "Plumbing Fixture & Equipment Schedule".

B. The sizes indicated on the Schedule are for drainage and water piping serving an individual fixture; the sizes of the mains and branches shall be as indicated on the drawings.

3.2 FIXTURE SETTING HEIGHTS

A. The plumbing fixtures shall be set in accordance with the heights established by the latest edition of codes and ADA requirements.

Note: Height indicated is established as follows:

Water Closets:	From finished floor to top of seat.
Urinals:	From finished floor to rim of fixture.
Lavatories & EWC:	From finished floor to rim of fixture.
Receptor Fitting:	From finished floor to center of fitting.
Shower:	From finished floor to center of shower head.

B. Refer to Architectural drawings and sections for fixture elevations. Fixtures in various areas may be set at lower elevations. Confirm <u>all</u> rough-in elevations prior to any installation.

3.3 LAVATORY PROTECTIVE SHIELD ENCLOSURES

A. Installation shall conform to manufacturer’s written instructions.

B. All items involved with wall-hung lavatory installations shall be roughed-in and installed within the enclosure. This includes the offset “P” trap assembly, thermostatic mixing valve, sensor faucet trim and accessories, electrical outlet. Coordinate all work required for complete concealment of all devices.

C. Protective shield enclosures are required on the toilet room’s countertop lavatories and are furnished by the Architect. Coordinate all trim and accessories to fit within this enclosure.

3.4 INSPECTION AND PREPARATION

A. Examine roughing-in work of domestic water and waste piping systems to verify actual locations of piping connections prior to installing fixtures. Also examine floors and substrates, and conditions

under which fixture work is to be accomplished. Correct any incorrect locations of piping, and other unsatisfactory conditions for installation of plumbing fixtures. Do not proceed with work until satisfactory conditions have been corrected.

B. Install plumbing fixtures of types indicated where shown and at indicated heights; in accordance with fixture manufacturer's written instructions, roughing-in drawings, and with recognized industry practices. Ensure that plumbing fixtures comply with requirements and service intended purposes. Comply with applicable requirements of the International Plumbing Code pertaining to installation of plumbing fixtures.

C. Fasten plumbing fixtures securely to indicated supports or building structure; and ensure that fixtures are level and plumb. Secure plumbing supplies behind or within wall construction so as to be rigid, and not subject to pull or push movement.

3.5 CLEAN AND PROTECT

A. Fixture shall be thoroughly cleaned after completion of installation.

B. Protect installed fixtures from damage during the remainder of the construction period.

3.6 FIELD QUALITY CONTROL

A. Upon completion of installation of plumbing fixtures and after units are water pressurized, test fixtures to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.

B. Inspect each installed unit for damage to finish. If feasible, restore and match finish to original at site; otherwise, remove fixture and replace with new unit. Feasibility and match to be judged by Architect/Engineer. Remove cracked or dented units and replace with new units.

END OF SECTION 220140

SECTION 220160: COMPRESSED AIR SYSTEM - PLUMBING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this Section.

1.2 DESCRIPTION OF WORK

A. Refer to Section 220005 for a general description of the scope of work in this contract.

B. This section includes:

1. Vertical air compressor unit.

2. All compressed air piping required including air service drops where noted and indicated on the drawings.

3. Compressed air filter - regulator assembly including quick disconnect couplers at the base of each air drop.

4. All testing and adjusting of the complete new system installed.

1.3 REFERENCE STANDARDS

A. Refer to Section 220000 for a general description of requirements applying to this section.

1.4 QUALITY ASSURANCE

A. Refer to Section 220010 for a general description of requirements applying to this section.

1.5 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 220000.

B. Submit the following:

1. Product data on all systems equipment.

C. See requirements for submission of cross referencing information.

1.6 WARRANTY/GUARANTEE

A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, GENERAL REQUIREMENTS.

PART 2 PRODUCTS

2.1 COMPRESSED AIR PIPING MATERIALS

A. Comply with basic piping materials and equipment sections for product requirements of piping materials. For each service, provide piping materials indicated including pipe, fittings, hangers, supports, anchors, valves and accessories.

B. Materials: Provide products complying with ANSI/ASME B31.1, "Power Piping", where type is not indicated.

C. Compressed Air Piping:

All sizes: Galvanized steel pipe of sizes indicated.

1. Pipe Weight: Schedule 80.
2. Fittings: Class 150 galvanized malleable iron threaded.

D. Compressed Air Valves:

1. Pipe Size: All sizes: Carbon steel, ball type.
2. Pressure Rating: 400 psi C.W.P.
3. Seat/Seals: Reinforced Teflon seats and seals.
4. Body Construction: One piece body design - non-blowout stem.
5. Ends: Threaded.

2.2 REGULATOR ASSEMBLIES

A. 1/2" combination unit filter - air regulator and gauge - lubricator assembly with 0-250 psi reduced pressure range and 2" 0-160 pressure gauge.

B. Industrial standard free swiveling type, air coupler and nipple fittings. Note: Coupler fittings to match air connection fittings of fire truck installations.

C. Subject to compliance with specifications, manufacturers of industrial plant air assemblies shall be limited to the following:

Lincoln/St. Louis
Norgren
Wilkerson
Wilkins
Leslie
Pennwalt

2.3 AIR COMPRESSOR

A. Two-stage reciprocating Simplex air compressor, top mounted vertical tank arrangement, similar to Quincy "Air-Star", 125 psig, 5HP, 18CFM, 208 volts, 3 phase, 1050 RPM operation.

B. Standard features included with the unit shall be as follows:

ASME 200 psig 80 gallon vertical coded tank
OSHA approved beltguards
Energy efficient fin and tube aftercooler
High efficient intercooler
Automotive type oil level gauge
Replaceable stainless steel valves
Cast aluminum piston
Cast on oil dippers
Two piece connecting rods
Oversized ball type main bearings
Ductile iron, counterweighted double throw crank shaft.
Removable oil pan
One piece heavy duty cast iron crankcase and cylinders.

C. Subject to compliance with specifications, manufacturers of air compressors shall be limited to the following:

Quincy
Curtis
Ingersol-Rand
Saylor-Beall
Kellog-American

PART 3 EXECUTION

3.1 INSTALLATION OF COMPRESSED AIR PIPING

A. Comply with requirements of other Division 22 sections for installation of basic piping materials. Install compressed air piping products and equipment where shown, in accordance with manufacturer's written instructions, applicable requirements of ANSI/ASME B31.1 and in accordance with recognized industry practices to ensure that products serve intended functions.

B. Run piping level where possible. When necessary to pitch piping, grade toward risers or drops and install without traps.

C. Take branch air lines from top of main only. Take branch mains from top or side of main header only.

D. Provide drains, drips or drip legs equipped with 1/2" valves with nipples and brass caps at lowest points in mains, branches and risers to drain condensed water from all sections of piping.

E. Provide quick connect couplings at the base of all general purpose compressed air drops. Coupling shall be set at 5'-0" A.F.F.

3.2 PIPING ISOLATION

A. Install piping isolators in accordance with other Division 22 Sections.

3.3 FIELD QUALITY CONTROL

A. Compressed Air Piping Leak Test: Prior to initial operation of piping system, air purge lines with oil-free dry air, and perform a 24-hour standing pressure time-test. Charge line with compressed air to 150 psi; maintain test pressure for 24-hours with a pressure loss no greater than 5 psi. During pressure test, test joints and fittings for leaks with soap bubble solution; while bubble testing, hammer joints with rubber or rawhide mallet to break hardened flux.

B. Repair or replace compressed air piping as required to eliminate leaks, and retest as specified to demonstrate compliance.

3.4 INSTALLATION OF AIR COMPRESSOR

A. Install compressor unit where indicated on drawings. Set unit so that proper clearances are provided for maintenance and repair.

B. Provide a 4" high concrete pad suitable to the diameter of the tank. Provide neoprene vibration isolation pads under each tank leg. Bolt down tank to pad.

C. Install the compressor unit in complete accordance with manufacturer's written instructions.

END OF SECTION 220160

SECTION 220190: TESTING - PLUMBING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other conditions, if any) and Division 1 as appropriate, apply to the work specified in this Section.

1.2 DESCRIPTION OF WORK

A. Refer to Section 220005 for a general description of the scope of work in this contract.

B. Extent of plumbing systems to be tested is indicated on the drawings and by requirements of this section.

C. Applications of tests include the following:

1. Interior Piping

a. Domestic cold, hot & hot water return piping
b. Gas piping
c. Sanitary and condensate waste drainage piping
d. Storm water drainage piping
e. Compressed air piping

2. Exterior Piping

a. Sanitary drainage piping
b. Domestic water service
c. Gas service
d. Storm drainage piping

1.3 REFERENCE STANDARDS

A. Refer to Section 220000 for a general description of requirements applying to this section.

1.4 QUALITY ASSURANCE

A. Refer to Section 220010 for a general description of requirements applying to this section.

1.5 SUBMITTALS

A. Submit test reports in accordance with Section 220000.

1.6 WARRANTY/GUARANTEE

A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, GENERAL REQUIREMENTS.

PART 2 PRODUCTS

2.1 PIPE & FITTING REPLACEMENTS

A. Refer to Section 220010 for replacement of any defective pipe or fittings. Replacement shall include all required uncovering, excavating, recovering and backfilling.

PART 3 EXECUTION

3.1 GENERAL

A. All exterior or interior piping shall be tested and approved before backfilling or concealing. Failure to secure the approval of the Municipal Inspector, Utility Company's Inspector or the Inspector of the Architect/Engineer makes it mandatory for the Contractor to completely expose the piping for testing. All expense involved in the uncovering of the piping for the test and recovering shall be borne by the respective Contractor with no change in Contract.

B. All equipment, material and labor required for testing a plumbing system or part thereof shall be furnished by the Plumbing Contractor responsible for installing the work.

3.2 INTERIOR PIPING

A. Drainage Piping:

Rough Plumbing: The piping of all plumbing storm, condensate waste, sanitary drainage and venting systems shall be tested upon completion of the rough piping installation by water or air and proved watertight. Where required by the code official, the cleanout plugs shall be removed to ascertain if the pressure has reached all parts of the system. Either of the following methods shall be used:

1. Water Test: The water test shall be applied to the drainage system either in its entirety or in sections after rough piping has been installed. If applied to the entire system, all openings in the piping shall be closed, except the highest opening, and the system filled with water to the point of overflow. If the system is tested in sections, each opening shall be plugged except the highest opening of the section under test, and each section shall be filled with water, but a section shall not be tested with less than a 10-foot head of water.

   In testing successive sections, at least the upper 10 feet of the next preceding section shall be tested, so that a joint or pipe in the building (except the uppermost 10 feet of the system) shall not have been subjected to a test of less than a 10-foot head of water. The water shall be kept in the system or in the portion under test for a minimum of 15 minutes before inspection starts. The system shall then be tight at all points.

2. Air Test: The air test shall be made by attaching an air compressor testing apparatus to an opening, and, after closing all other inlets and outlets to the system, forcing air into the system until there is a gauge pressure of 5 pounds per square inch (5 psi) or a minimum of 10-inch

column of mercury.

This pressure shall be held without introduction of additional air for a minimum period of 15 minutes.

Finished Plumbing: Where required by the code official, after the plumbing fixtures have been set and their traps filled with water, their connections shall be tested and proved gas and water-tight by one of the following test methods.

1. The final test for gas and water-tightness of the completed drainage and vent systems shall be made by a smoke test or other approved method. The test shall be made by filling all traps with water, and then introducing into the system smoke produced by one or more smoke machines. When the smoke appears at stack openings on the roof, the stack openings shall be closed and a pressure equivalent to a 1" water column shall be built and maintained for the period of the inspection.

2. After the plumbing fixtures have been set and their traps filled with water, their connections shall be tested and proven gas and water-tight by plugging the stack openings on the roof and building drain where the drain leaves the building and with air introduced into the system equal to the pressure of a 1-inch water column. This shall be accomplished by the use of a "U" tube or manometer inserted in the trap of a water closet. Such pressure shall remain constant for the period of inspection without the introduction of additional air.

Building sewer test: The building sewer shall be tested by insertion of a test plug at the point of connection with the public sewer or individual sewage disposal system. The building sewer shall then be filled with water under a head of not less than 10 feet. The water level at the top of the test head of water shall not drop for at least 15 minutes.

B. Domestic Water Piping: All new, altered, extended or replaced interior water piping installed shall be tested at 100 psig maintaining the pressure for four hours with not more than 1% drop in pressure. The system shall be filled with water which shall remain in the system until the water and the piping are the same temperature. If water pipe testing is under the jurisdiction of the local inspector, his requirements shall be used; however, they shall be not less than specified herein. The tests shall be performed in the presence of the representative of the Architect/Engineer and to his satisfaction.

C. Natural Gas Piping:

1. All new, altered, extended or replaced interior natural gas piping installed shall be tested in accordance with the requirements of the National Fire Protection Association, latest edition of the IFGC, Section 107, and the requirements of the local Utility Company as applicable. In the absence of a specific test required by the Authorities, or if such requirements are less stringent than the test hereinafter specified, then the interior gas piping shall be tested as follows in the presence of the representative of the Architect.

2. Before appliances are connected, piping shall be filled with air or nitrogen, to a pressure of 10 psi and proved tight with no drop in pressure for the length of time required to inspect the joints, but in no case less than 30 minutes. The source of pressure shall be isolated before the pressure tests are performed. Pressure shall be measured with a mercury manometer, or slope gauge or equivalent device so calibrated as to be read in increments of not greater than one-tenth pound. All piping which will be concealed shall be tested, prior to being closed in by construction.

D. Compressed Air Piping: Compressed air piping shall be tested at 125 psi. The pressure shall be

maintained on the system a minimum of 30 minutes without any loss in pressure. If a loss in pressure occurs, leakage shall be corrected and piping retested.

3.3 EXTERIOR PIPING

A. Sanitary & Storm Water Drainage Piping:

1. All new exterior sanitary and storm water drainage installed shall be tested in a manner and in a sequence best suited to project. The test shall be performed in the presence of the Inspector of the Municipality under whose jurisdiction the installation is made and shall conform to his requirements.

2. In the absence of a specific code test, the Contractor shall perform the following testing in the presence of the representatives of the Architect.

3. Before any section of sanitary and storm water drainage has been backfilled more than 6 inches above the top of the pipes, exclusive of the joint area, the system shall be tested. Wherever possible, the section of the system shall be tested from manhole to manhole. The lower end of each section to be tested shall be plugged with a suitable device manufactured for this purpose. The section being tested shall be filled with water and the leakage observed and gauged.

4. For the gravity sanitary drainage piping to be acceptable, the water leakage after filling shall not exceed 2 gallons per 24 hours per lineal foot of pipe joints with all joints under a constant pressure of not less than 0.1 pound.

5. For the storm water to be acceptable, the water leakage after filling shall not exceed 3 gallons per 24 hours per lineal foot of pipe joints with all joints under a constant pressure of not less than 0.1 pound.

B. Domestic Water Service: All new exterior water service piping installed shall be tested and proved tight. In the absence of specific requirements or requirements less stringent than those specified herein, this contractor shall test the piping at a minimum pressure of 125 psig maintaining the pressure for two hours without more than 2% drop in pressure. The system shall be filled with water which shall remain in the system until the water and piping are the same temperature.

C. Gas Service:

1. All new exterior distribution piping, installed by this Contractor, for natural gas systems shall be tested in accordance with the requirements of the National Fire Protection Association, latest edition of the IFGC, Section 107, and the requirements of the local Utility Company. In the absence of a specific test required by the Authorities, or if such requirements are less stringent than the test hereinafter specified, then the exterior piping shall be tested as follows, before pressure regulating valves are installed, or connection made to interior piping.

2. Piping shall be filled with air or nitrogen, to a pressure of 100 psi, and proved tight with no drop in pressure for the length of time required to inspect the joints, but in no case less than one hour. The source of pressure shall be isolated before the pressure tests are performed. Pressure shall be measured with a gauge so calibrated as to be read in increments of not greater than one pound.

3.4 STERILIZATION

A. After final testing for leaks, all new potable water piping installed including water service piping, shall be flushed to remove foreign material.

B. Before placing domestic water systems in service, a qualified service organization shall be engaged, to sterilize the entire building including the exterior water service piping in accordance with the following procedure:

1. Contractor shall provide a 3/4" hose connection somewhere in the main entering the building, or in the Mechanical Room and/or in the meter pit, pump in sufficient sodium hypochlorite to produce a free available chlorine residual of not less than 100 PPM.

2. Proceed upstream from the point of chlorine application opening all faucets and taps until chlorine is detected. Close faucets and taps when chlorine is evident. Consult with the local code department for additional concentrations and durations.

3. When chlorinated water has been brought to every faucet and tap with a minimum concentration of 200 PPM chlorine, retain this water in the system for at least three hours.

4. At the end of the retention period, no less than 100 PPM of chlorine shall be present at the extreme end of the system.

5. Proceed to open all faucets and taps and thoroughly flush all new lines until the chlorine residual in the water is less than 1.0 PPM.

6. Obtain representative water samples from the system for analysis by a recognized Bacteriological Laboratory.

7. If all samples tested for impurities and organisms are negative, a letter and laboratory reports shall be submitted by the service organization to the contractor, certifying successful completion of the sterilization.

8. If any samples tested indicate the presence of harmful impurities and organisms, the entire sterilization procedure shall be repeated.

9. Plumbing Contractor shall provide plumbing connections and power for pumping chlorine solution into the system.

Warning: PVC and CPVC Pipe: Do not use a dry granular calcium hypochlorite as a disinfecting material for water purification in potable water piping systems. The introduction of granules or pellets of calcium hypochlorite with solvent cements and primers (including their vapors), may result in violent chemical reactioins.

C. Available Service Organizations: Subject to compliance with requirements, provide the sterilization service of one of the following:

Water Chem
Arc Company, Inc.
Nova Consultants
Artesian Water Co.

END OF SECTION 220190

SECTION 220191: BALANCING- PLUMBING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other conditions, if any) and Division 1 as appropriate, apply to the work specified in this Section.

1.2 DESCRIPTION OF WORK

A. Refer to Section 220005 for a general description of the scope of work in this contract.

B. Extent of plumbing systems to be balanced is indicated on the drawings and by requirements of this section.

C. Applications of tests include the following:

1. Interior Piping

a. Domestic hot water and hot water return

1.3 REFERENCE STANDARDS

A. Refer to Section 220000 for a general description of requirements applying to this section.

1.4 QUALITY ASSURANCE

A. Refer to Section 220010 for a general description of requirements applying to this section.

1.5 SUBMITTALS

A. Submit balancing report in accordance with Section 220000.

1.6 WARRANTY/GUARANTEE

A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, GENERAL REQUIREMENTS.

PART 2 PRODUCTS

2.1 PIPE & FITTING REPLACEMENTS

A. Refer to Section 220010 for replacement of any defective pipe or fittings. Replacement shall include all required draining of system, removal and replacement and uncovering, recovering.

PART 3 EXECUTION

3.1 GENERAL

A. All new hot water return piping installed or wherever system valves are being replace, the system shall be tested, balanced and approved before concealing. Failure to secure the approval of the Municipal Inspector, A/E Inspector or the Inspector of the Owner makes it mandatory for the Contractor to completely expose the piping for balancing. All expense involved in the uncovering of the piping for the balancing and recovering shall be borne by the respective Contractor with no change in Contract.

B. All equipment, material and labor required for balancing a plumbing system or part thereof shall be furnished by the Plumbing Contractor responsible for installing the work.

3.2 INTERIOR PIPING

A. Domestic Hot Water Return System: Upon completion of the testing of the domestic hot water supply and recirculation systems, a final procedure is to be performed to obtain uniform circulation within each hot water loop of the domestic hot water system. At the ends of the hot water mains, or wherever a branch return line connects to the main return line, there shall be three (3) valves: ball valve, check valve and balancing valve. These valves are to be installed in an accessible space at/or above the ceiling or where indicated on the drawings.

B. Based on an Accu-Flo balancing valve, the use of a differential pressure gauge Model No. 779 shall be used to achieve the greatest accuracy.

END OF SECTION 220191

SECTION 230200: GENERAL PROVISIONS - HVAC

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to work of this Section.

B. All Mechanical Systems shall be part of and included in all of the following: 230200 thru 230960

C. Refer to Section 078413 for Through-Penetration Firestop Systems.

D. Refer to Section 083113 for Access Doors and Frames

1.2 WORK INCLUDED

A. Provide labor, materials, equipment and supervision necessary to install complete operating HVAC Systems, including all work at the site and within the proposed construction areas to accomplish the required work.

B. Wherever the term "provide" is used, it shall be understood to mean both "furnish" and "install".

1.3 REGULATIONS, CODES AND STANDARDS

A. Work shall be performed in accordance with latest adopted codes, regulations and ordinances by authorities having jurisdiction. Observe all safety regulations.

B. Obtain all permits and inspection certificates and pay all charges.

C. Latest editions of any referenced standards shall govern.

1.4 RELATED WORK

A. Refer to equipment shown or specified in sections of Division 1 thru 14 and 26 that will require Mechanical services and provide such service.

B. Refer to work related to HVAC as shown on the following contract drawings:

Architectural & Structural
Plumbing
Electrical

C. This Contractor shall coordinate with the work of Division 26 and the Fire Alarm System vendor for locations and mounting of all duct smoke detectors. These devices are shown on the Mechanical Drawings for reference only to show the intent of the work. All locations shall be determined based

on approved shop drawings from the Fire Alarm System vendor and the Contractor for the work of Division 26, Electrical.

1.5 COORDINATION

A. The Mechanical, Plumbing and Electrical Contractors are responsible to coordinate all manufacturer's recommended circuit breakers, starters, disconnects and fuse sizes for all equipment. Submission of a shop drawing will certify that this has been completed. Any necessary changes required will be included as part of this contract.

B. Mechanical Contractor shall coordinate scheduling, submittals and work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of independent work elements, with provisions to accommodate items that may be installed at a later time.

C. Mechanical Contractor shall verify utility requirements and all characteristics of operating equipment are compatible with the building utilities. Coordinate the work of all sections related and required for installing, connection and placing in service of all equipment.

D. Mechanical Contractor shall coordinate all space requirements, supports and installation of all mechanical, electrical, plumbing and fire protection work, which are indicated diagrammatically on the Drawings. Verify routing of all pipes, ducts, conduits and equipment connections. Maximize accessibility for other work, and service requirements for maintenance and repairs.

F. Submit coordination drawings to verify access and clearances.

1.6 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations..

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installation within unheated shelters.

1.7 SUBMITTALS

A. Shop Drawings:

1. Shop drawings shall be submitted in accordance with Division 1 of these specifications except where herein modified.

2. Shop drawings comprising complete catalog cuts, performance test data for HVAC equipment as required by other sections of Division 23, shall be submitted for review checking. The Contractor shall review these shop drawings for conformance to contract documents prior to submission and affix contractor's signature to each submittal certifying that this review has been done. By approving and submitting shop drawings, product data, samples and similar materials, the Contractor represents that the Contractor has determined and verified materials, field measurements and field construction data that relates to the work, and has checked and coordinated this information with all of the requirements contained in the contract documents for the work of all trades.

3. Submit a 1/4" scale layout of all mechanical equipment rooms. All equipment and pads shall be to scale of equipment being furnished. Obtain size information of any and all equipment from other trades and indicate on drawings. The drawings shall be fully coordinated with all trades prior to submission. Indicate coil pull areas, filter pull areas, maintenance clearances, and access as applicable.

4. All shop drawing submittals shall have the following identification data, as applicable, contained therein or permanently adhered thereto.

   a. Project name.

   b. Project number.

   c. Sub-contractor's, vendor's and/or manufacturer's name and address.

   d. Product identification.

   e. Identification of deviation from contract documents.

   f. Applicable contract drawings and specification section number.

   g. Shop drawing title, drawing number, revision number, and date of drawing and revision.

   h. Resubmit revised or additional shop drawings as requested.

   i. Wherever shop drawings or vendor's standard data sheets indicate work to be done "by others", it shall be the responsibility of the contractor making the submission to identify by name, the contractor who is to do this work. If the contractor named is other than the contractor making the submission, the shop drawing submission must be reviewed by the named contractor and bear his mark of approval, prior to submission to the Architect/Engineer.

   j. Where equipment proposed differs from that shown on the drawings or specified, he shall submit for approval drawings showing the manner in which the layout is affected by the substitution.

k. The Contractor shall keep one copy of approved shop drawings at the job site,, filed in a suitable metal container. The shop drawings shall be cataloged and kept in good repair, and shall be available for use by the Owner, Architect and Engineer.

l. No equipment shall be ordered, fabricated, etc., before approval of shop drawings.

B. Contractor is responsible for the shop drawing coordination and interface with the work of other contracts and adjacent work. The relationship of Contractor's work shall be verified as it relates to adjacent and critical features of the work of this and all contracts and materials.

C. The Contractor shall submit a complete schedule of all shop drawings required for the scope of work covering all materials and equipment listed in all sections of Division 23, Mechanical, including all documents required for contract closeout, Owner instructions and training, and all turnover items at the completion of the work. This schedule shall be submitted for review and approval within thirty days of contract award and before any subsequent materials are provided for review.

D. The shop drawings provided by the Contractor will be reviewed only once and resubmittals will be reviewed only once. Any other submittals will be billed to the Contractor at the Engineer's standard rates.

1.8 SITE INSPECTION

A. The Contractor shall visit site, inspect, and become aware of all conditions which may effect the work during the estimation phase of his work prior to bid openings. Investigate utilities, protection requirements for adjacent facilities, storage locations, and access to the construction area.

B. Submission of a bid will be deemed evidence of having complied with this requirement.

1.9 SUBSTITUTIONS

A. Whenever a material, article, piece of equipment or system is identified in the following specification or indicated on the drawings by reference to manufacturers' or vendors' names, trade names, catalog numbers or the like, it is so identified for the purpose of establishing the basis of the Bid.

B. Substitution approval must be obtained and included as an addendum item prior to the submission of the bid. An approved substitution shall not be considered as an approval for the Contractor or an equipment vendor to deviate from the written portion of the specifications unless so stated in the addendum.

C. The drawings illustrate the space allocated for equipment and the Contractor shall install the equipment accordingly. If changes are required in the building or arrangement due to substitution of equipment, the Contractor making the substitution must pay for the necessary modifications.

D. The listed equivalent or substituted manufacturers along with the bidding related contractor shall be completely responsible to comply with all requirements on all contract documents. This shall include, but shall not be limited to space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades, including all required ancillary items provided by other trades. If the manufacturer or related bidding contractor does not comply

with these requirements, then they shall be responsible for any and all additional costs associated with the changes required by other trades.

E. Substitutions:

1. Until a date no later than seven (7) days before the date Bids are due, Architect will consider written requests from bidders for substitution of Products. Architect will review requests and will notify Bidders in an Addendum if the requested substitution is acceptable.

2. Submit a separate request for each Product, supported with complete data, with drawings and samples as appropriate, including:

   a. Comparison of the qualities of the proposed substitution with that specified.

   b. Changes required in other elements of the work because of the substitution.

   c. Effect on the construction schedule.

   d. Cost data comparing the proposed substitution with the Product specified.

   e. Any required license fees or royalties.

   f. Availability of maintenance service, and source of replacement materials.

3. Architect shall be the judge of the acceptability of the proposed substitution.

4. A request for a substitution constitutes a representation that Bidder:

   a. Has investigated the proposed Product and determined that it is equal to or superior in all respects to that specified.

   b. Will provide the same warranties or bonds for the substitution as for the Product specified.

   c. Will coordinate the installation of an accepted substitution into the work, and make such other changes as may be required to make the work complete in all respects.

   d. Waives all claims for additional costs, under his responsibility, which may subsequently become apparent.

1.10 LUBRICATION

A. Provide and maintain all required lubrication of any equipment operated prior to acceptance by the Owner. Lubrication shall be as recommended by the equipment manufacturer.

B. Provide one year's supply of lubricants to Owner at date of acceptance.

C. Verify that required lubrication has taken place prior to any equipment start-up.

1.11 EQUIPMENT START-UP

A. Verify proper installation by manufacturer or his representative.

B. Advise General Contractor2 days prior to actual start-up.

C. Verify proper operation. Obtain signed statement by manufacturer or his representative that equipment is operating within warranty requirements. Submit statement to General Contractor.

D. Perform field mechanical balancing in accordance with Section 230950: TESTING AND BALANCING OF MECHANICAL SYSTEMS.

1.12 OPERATION & MAINTENANCE INSTRUCTIONS

A. Properly and fully instruct Owner's personnel in the operation and maintenance of all systems and equipment.

1. Contractor to demonstrate all systems to Engineer for verification of operation prior to Owner's instruction period.

2. Provide two (2) 4-hour sessions of training to DTCC Maintenance Staff.

B. Insure that the Owner's personnel are familiar with all operations to carry on required activities.

C. Such instruction shall be for each item of equipment and each system as a whole.

D. Provide report that instruction has taken place. Include in the report the equipment and/or systems instructed, date, contractor, Owner's personnel, vendor, and that a complete operating and maintenance manual has been reviewed.

E. Manual shall include all instructions on operation, maintenance, repair parts list, lubrication requirements, brochures, catalogue cuts, complete schedule of air filters for each unit type in Excel spreadsheet format, wiring diagrams, piping diagrams, control sequences, service requirements, names and addresses of vendors, suppliers and emergency contacts. Three manuals shall be provided.

F. Submit manuals for review prior to operating instruction period. Manuals shall be 8-1/2 x 11" with hard cover, suitably bound.

G. Provide to the Owner any special tools necessary for operation and routine maintenance of any of the equipment.

H. Upon completion of the project, the Mechanical Contractor shall provide a complete set of legible as-built drawings for the Owner.

1.13 TOOLS

A. All equipment furnished by the Mechanical Contractor which requires special tools or devices other than those normally available to the maintenance or operating staff shall be furnished in duplicate to

the Owner, sufficiently marked, packed or boxed for staff usage. The tools provided shall be listed by the Mechanical Contractor identified as to their use or the equipment applicable in a written transmittal to the Owner.

1.14 CLEANING AND FINISHING

A. After equipment start-up and all operating tests have been made and the system pronounced satisfactory, each respective Contractor shall go over the entire project, clean all equipment, etc., installed by him and leave in a clean and working condition. Any surfaces found marred after this final cleaning shall be refinished or replaced by each Contractor at no cost to the Owner.

B. Provide for the safety and good condition of all materials and equipment until final acceptance by the Owner. Protect all materials and equipment from damage. Provide adequate and proper storage facilities during the progress of the work. Special care shall be taken to provide protection for bearings, open connections, pipe coils, pumps, compressors and similar equipment.

C. All fixtures, piping, finished surfaces and equipment shall have all grease, adhesive labels and foreign materials removed.

D. All piping shall be drained and flushed to remove grease and foreign matter. Pressure regulating assemblies, traps, and similar items shall be thoroughly cleaned. Remove and thoroughly clean and reinstall all liquid strainer screens after the system has been in operation ten (10) days.

E. When connections are made to existing systems, the Mechanical Contractor shall do all cleaning and purging of the existing systems required to restore them to the condition existing prior to the start of work.

F. Clean-up: Remove from the premises, all unused material and debris resulting from the performance of work under this section.

PART 2 PRODUCTS

2.1 GENERAL

A. All material and equipment shall be new and of present day manufacture, and shall conform to accepted standards of the trade where such a standard has been established for the particular type of equipment or material.

B. Whenever equipment or material is referred to in the singular, such as "the fan", it shall be deemed to apply to as many such items as necessary to complete the work.

2.2 PRODUCT DELIVERY, STORAGE AND HANDLING

A. During loading, transporting and unloading exercise care to prevent damage to material.

B. Store all materials in dry enclosures or under protective coverings out of way of work progress.

C. Material shall not be allowed to be stored directly on ground.

D. Deliver in manufacturer's original cartons or on skids.

E. Handle and protect so as to prevent damage to product or any surrounding material.

2.3 CONCRETE

A. Concrete shall be in accordance with Section 033000.,

2.4 WARRANTY

A. Wherever in the specification sections of this division, reference is made to a specific warranty period, this warranty shall be in addition to and not a limitation of other rights the Owner may have against the Mechanical Contractor under the contract documents.

PART 3 EXECUTION

3.1 PROTECTION

A. Plug or cap open ends of piping systems, conduit and ductwork.

B. Stored materials shall be covered to prevent damage by inclement weather, sun, dust or moisture.

C. Protect all installed work until accepted in place by the Owner.

D. Plates, polished metal escutcheons, thermostats and other finished devices shall not be installed until masonry, tile, and painting operations are complete unless otherwise protected.

E. Protect all work from operations which may cause damage such as hauling, welding, soldering, painting, insulating and covering.

3.2 WORKMANSHIP

A. Install all work neat, trim and plumb with building lines.

B. Install work in spaces allocated.

C. Cutting and patching shall be performed by skilled tradesmen normally employed for the work involved.

D. This Contractor shall provide a complete weathertight seal to all new systems in the building including the necessary caulking, weatherstripping and insulation.

3.3 EXCAVATION

A. The excavation shall be of the open-trench method and to the depths and widths as may be necessary. The Mechanical Contractor shall do all excavation required in connection with his work. Bottoms of trenches shall be excavated to a uniform grade. All materials excavated shall be deposited on the side of the trenches and beyond the reach of the slides. Excavated material shall not be piled where it will

interfere with traffic. If rock is encountered, it shall be removed by the General Contractor. See provisions in Division 2.

B. No conduits shall be bedded directly on rock. They shall be cushioned by a 6-inch layer of crushed stone or gravel of selected grade, of size to pass through 3/4" mesh sieve. Not less than 30% shall be fine which will pass through a 3/8" mesh sieve.

3.4 SHORING AND PUMPING

A. The Mechanical Contractor shall provide all shoring, bracing or sheet piling necessary to maintain the banks of his excavation and shall take out same as the work progresses and filling in has been accomplished. Shoring shall be in accordance with OSHA Standards.

B. The arrangement of shoring must be such as to prevent any movement of the trench banks and consequent strains on the conduits. Shoring shall be provided to prevent damage to work installed by other trades.

C. The Mechanical Contractor shall do all pumping required to keep his excavations free of water. The water shall be conveyed in piping or watertight troughs a sufficient distance that it will flow from the site and not affect other work being performed.

3.5 BACKFILLING

A. After work in trenches has been completed, they shall be filled with select fill in 8" layers and shall be pneumatically tamped before the next layer of material has been filled in. The backfill shall be free of excavated rock, cinders, stones, brickbats or other debris.

B. Wherever rock is removed, the Mechanical Contractor shall secure and fill select clean earth to a minimum depth of 3'-0" above the top of the pipe. Unless otherwise indicated, no rock shall be deposited in the trench fill. This clean earth fill shall be procured other than from the site unless permission for earth borrow from the site is granted by the Architect. If site borrow is permitted, the topsoil removal, relocation and finished grading will be accomplished as directed by the Architect.

C. Under no circumstances shall excavated material be left where it will interfere with the Owner's or other Mechanical Contractor's operations.

D. All earth and other materials taken from the trenches and not required for backfilling shall be deposited where directed, or removed from the premises as directed by the Architect.

E. Any rock removed from the excavation shall be removed from the project site by the Mechanical Contractor.

F. Trenches which pass under wall footings or within 18" of column footings shall be backfilled with clean concrete. To secure adequate foundation support, the method and depositing of the concrete fill shall be as directed by the Architect. To prevent the concrete from adhering to the pipe, necessary pipe protection shall be applied.

3.6 EQUIPMENT SETTING

A. Provide as a minimum, a 4 inch concrete pad beneath all floor-mounted equipment. Install anchor bolts in pour.

B. Provide as a minimum, spring vibration isolation under any equipment 10 HP and over and rubber in shear vibration isolation on any equipment up to 10 HP. For further specifications and additional requirements, refer to other sections.

C. Concrete shall be 3,000 psi, 28 day compressive strength in accordance with ACI-613. Reinforce with No. 4 rod 12" on centers both ways or as otherwise detailed.

3.7 FASTENERS, HANGERS AND SUPPORTS

A. Provide all hangers and supports required to suspend, mount, or hang the work.

B. Provide all miscellaneous steel angles, channels, beams, clips, brackets and anchors necessary to hang or support the work. Provide submissions for review.

C. Install concrete inserts before concrete is poured.

D. Drilled inserts shall not be loaded more than 1/4 rated capacity.

E. Power-driven fasteners shall not be allowed for piping larger than 2 inch, or equipment. When used they shall not be loaded more than 1/8 rated capacity or 200 pounds.

F. All hangers, miscellaneous steel, braces and supports shall be galvanized, cadmium plated, or primed steel. Copper tubing shall be supported with copper hangers.

G. Piping shall be supported from adjustable clevis type hangers with insulation pipe saddles or pipe shields in accordance with piping support spacing table on the drawings. Where hangers are 18" or longer provide lateral bracing at every fourth hanger.

H. Support vertical piping at floor levels. Piping shall have split rings.

I. Any lintels required for openings for this work if not indicated on Architectural or Structural drawings shall be provided under this Section.

3.8 SLEEVES

A. Provide each pipe, duct or conduit passing through a masonry or concrete wall, floor or partition with a sleeve made from standard weight steel pipe for pipe or conduit and No. 12 gauge galvanized steel for ducts, with smooth edges, securely and neatly cemented in place. Provide each pipe, duct or conduit passing through a frame or metal partition with a sleeve made from No. 22 gauge galvanized sheet metal, securely fastened in place.

B. Be responsible for the proper location and alignment of all sleeves.

C. Provide hydrostatic seals for sleeves passing through outside walls, either above or below grade, or through hydrostatically sealed slabs or floors on grade. Provide fire-rated seals for all sleeves which penetrate fire-rated walls.

D. Install both piping and sleeve seals so as to maintain integrity of seals with expansion and contraction of piping.

E. Set floor sleeves flush with floor surface in finished areas, 1" above the finished floor in kitchens, cafeterias, and similar service areas unless such areas are slab-on-grade; 1" above the floor in mechanical rooms, pipe chases, pipe spaces and other unfinished areas, unless otherwise indicated, and flush with the underside of slabs. Extend wall and partition sleeves through and cut flush with each surface unless otherwise indicated or specified.

F. Select sleeves two pipe sizes larger than any pipe or conduit that is to remain uncovered, unless otherwise required by the sealing method specified. Where pipes are to be covered, provide sleeves large enough to allow the covering to pass through the sleeves with sufficient clearance for sealing as specified hereinafter. Size sleeves for branch piping from vertical risers large enough to permit vertical expansion at the riser.

G. Select duct sleeve sizes to suit requirements of fire dampers and sealing methods as specified.

H. Place sleeves imbedded in concrete floors or walls in the forms before concrete is poured; sleeves shall have integral waterstop flanges, where they are to receive either watertight or hydrostatic seals.

I. Install sleeves passing through above-grade floors of mechanical rooms, toilet rooms, kitchens or similar service areas where liquid leaks or spillover may occur in a watertight manner. Sleeves shall be such that waterproofing membrane can be flashed around and into the sleeve where necessary.

J. Seal sleeves for pipes or conduit passing through ceiling air plenum walls or the floor above air tight in a manner similar to that specified for fire-rated sleeves.

K. Hydrostatic Sealing Method: Provide compressible synthetic rubber seals, equivalent to LINK SEAL, manufactured by the Thunderline Corporation, or THRUWALL manufactured by O.Z. Gedney. Install seals in accordance with the manufacturer's recommendations to provide air tightness aboveground and hydrostatic sealing belowgrade. Caulking or other type mastic is not acceptable.

L. Fire-Rated Sealing Method:

1. Fire stopping of all thru-penetrations of fire and/or smoke rated assemblies (partitions, floors, ceilings, etc.) shall be the responsibility of each installer or building trade (Mechanical, Plumbing, Electrical, Communications, Data, etc.) making the thru-penetrations, unless otherwise indicated on the Architectural series drawings (A-series). It is the responsibility of the Contractor making the thru-penetrations to verify and coordinate fire stopping with fire rating, assembly type and field conditions.

2. Sleeves, openings and sealants shall comply with applicable codes, recommended practices and standards, and manufacturer's instructions. Fire sealants shall have ability to prevent spread of flame, smoke or water throughout the penetration and shall pass 3 hour test, UL test ASTM E814 and UL 1479.

2. Products: Refer to Division 7 of the specifications for Fire Stopping Requirements.

3.9 PLATES

A. Provide chrome plated plates wherever piping passes into finished area.

B. Plates shall be securely fastened to piping or building construction.

C. Floor plates shall cover 1 inch sleeve extension.

3.10 OFFSETS, TRANSITIONS, MODIFICATIONS

A. Provide all offsets necessary to install the work and to provide clearance for other trades.

B. Maintain adequate headroom and clearance.

C. Incidental modifications necessary to the installation of the systems shall be made as necessary and as approved by the Architect.

3.11 RECESSES

A. Furnish information to the General Contractor as to sizes and locations of recesses required to install panels, boxes, and other equipment or devices which are to be recessed in walls.

B. Make offsets or modifications as required to suit final locations.

3.12 LABELING

A. All HVAC equipment such as pumps, fans, air handling units, and devices requiring identification for operating procedures shall be provided with permanent black laminated micarta white core labels with 3/8 inch letters.

B. This shall also apply to all controllers, remote start/stop pushbuttons and equipment cabinets.

C. This shall not apply to individual room thermostats.

D. All Mechanical Rooms shall be identified with a permanent placard of red-white-red laminated, commercial grade, plastic construction. Letters shall be minimum one inch high and read in capital letters: WARNING – MECHANICAL EQUIPMENT ROOM – LIMITED ACCESS. Placard shall be centered on each door leading into the mechanical room at five feet above the floor and attached at each corner with brass screws.

F. At all fire damper, smoke damper and combination fire/smoke damper locations, access doors in ductwork shall be identified with a permanent placard of red-white-red laminated commercial grade plastic construction, minimum one-half inch high capital letters, reading, “FIRE DAMPER”, “SMOKE DAMPER”, “FIRE/SMOKE DAMPER” as appropriate for the installation. Attached securely to face of access door with brass screws at each corner, sealed airtight.

3.13 FLASHING AND COUNTERFLASHING

A. Roof curbs, etc., shall have counterflashing fittings. General Contractor shall provide flashing.

B. Piping and conduit thru the roof shall be flashed by the General Contractor. Provide counterflashing.

C. Provide curbs with base features required to match roof materials, finishes and configuration; e.g., flat, sloped, raised seam, etc.

3.14 ACCESS

A. Locate all equipment, valves, devices and controllers which may need service in accessible places.

B. Where access is not available, access panels shall be provided.

C. Provide access panels as required by conditions, code or shown on the drawings. Unless otherwise indicated, all access panels shown on Architectural series drawings (A-series) shall be furnished and installed by substrate contractor (mason, gypsum drywall, plaster, etc.). Additional access panels required by and/or indicated on Mechanical, Plumbing, Electrical, etc., drawings shall be furnished and installed by that respective contractor. It is the responsibility of the Contractor furnishing the access panel to coordinate type with requirements for fire rating, wall type and thickness and wall finish. Refer to Division 8 of the specifications for access doors/panel requirements.

1. Single Source Responsibility: Obtain access doors for entire Project from one source and by a single manufacturer. Obtain access doors for entire project from one source and by a single manufacturer.

D. Maintain access clearances for tube or fan removal, coil pulls, and filter removal.

3.15 WIRING AND MOTOR CONTROLS

A. Packaged equipment shall be furnished with disconnect switches, starters, overloads, factory furnished and wired by the unit manufacturer.

B. Roof-mounted exhaust fans, except utility sets, rated less than 1/2 HP at 115 volts, single phase, shall be furnished with disconnect switches, factory furnished and wired by unit manufacturer.

C. Rooftop equipment shall be furnished with starters, disconnect switches, overloads, factory furnished and wired by unit manufacturer.

D. This Contractor shall furnish all information and assistance required for the Electrical Contractor to purchase all motor starters that are not specified to be part of the mechanical equipment.

E. Control wiring shall be provided under this Division of the work.

F. All wiring shall be in accordance with the National Electrical Code and as recommended by the equipment manufacturer.

3.16 UTILITIES

A. Do not interrupt any utility or service to the Owner without adequate previous notice and schedule.

3.17 CUTTING AND PATCHING EXTERIOR SURFACES

A. This Contractor shall be responsible for returning disturbed paved and/or grass areas to original condition where excavation for utilities has been required.

B. Cut and patch paved areas to match original surface.

C. Properly tamp backfill before finishing or repairing disturbed area surfaces.

3.18 OPENINGS - CUTTING, REPAIRING

A. This Contractor shall cooperate with the work to be done under other sections in providing information as to openings required in walls, slabs and footings for all piping, ductwork and equipment, including sleeves where required.

B. Any drilling or cutting required for the performance of work under this Section, shall be the responsibility of this Contractor and the cost thereof shall be borne by him.

C. Holes in Concrete: Sleeves shall be furnished, accurately located and installed in forms before pouring of concrete. This Contractor shall pay all additional costs for cutting of holes as the result of the incorrect location of sleeves. All holes through existing concrete shall be either core drilled or saw cut. All holes required shall have the approval of the Structural Engineer prior to cutting or drilling.

D. It shall be the responsibility of this Contractor to ascertain that all chases and openings are properly located.

3.19 PAINTING

A. The General Contractor shall be responsible for painting.

3.20 GUARANTEE

A. All work shall be guaranteed to be free from defects for a period of one year of operation from date of acceptance by the Owner.

B. Guarantee shall be extended on an equal time basis for all non-operational periods due to failure within the guarantee period.

C. All materials and equipment provided and/or installed under this section of the specifications shall be guaranteed for a period of one year from date of acceptance of the work by the Owner unless otherwise specified in Division 1. Should any trouble develop during this period due to defective materials or faulty workmanship, the Mechanical Contractor shall furnish necessary labor and materials to correct the trouble without any cost to the Owner. Any defective materials or inferior

workmanship noticed at time of installation and/or during the guarantee period shall be corrected immediately to the entire satisfaction of the Owner.

D. In the event of occupancy by the Owner prior to final acceptance of the project, the guarantee date for equipment placed in operation shall be mutually agreed to by the Mechanical Contractor and the Owner's representative.

3.21 DRAWINGS

A. Drawings are diagrammatic and indicate the general arrangement of systems and requirements of the work. Do not scale drawings. Exact locations of fixtures and equipment, not specifically shown, shall be obtained before starting work.

3.22 TESTING AND BALANCING OF MECHANICAL EQUIPMENT

A. Perform field mechanical balancing in accordance with Section 230950: TESTING AND BALANCING OF MECHANICAL SYSTEMS.

B. The Mechanical Contractor shall own as part of his work, the following:

END OF SECTION 230200

SECTION 230210: BASIC MATERIALS AND METHODS - HVAC

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.

B. Refer to Section 230200 for HVAC General Provisions.

C. Refer to other sections in Division 23 for materials and methods not specified herein.

1.2 DESCRIPTION OF WORK

A. Included in this Section are the following:

1. Steel Pipe and Fittings
2. Copper Tubing & Fittings
3. Strainers
4. Thermometers
5. Gauges
6. Test Stations - Pressure/Temperature
7. Isolating Fittings
8. Pipe Saddles
9. Anchors and Guides
10. Expansion Compensators
11. Flexible Expansion Loop
12. Unions
13. Motors

1.3 REFERENCE STANDARDS

A. Refer to Section 230200 for a general description of requirements applying to this section.

B. Install work to meet the requirements of the following:

1. New Castle County Dept. of License and Inspections
2. International Mechanical Code
3. Gas Utility Company
4. NFPA
5. OSHA
6. ASHRAE
7. Manufacturer's Standardization Society (MSS) of the valve and Fittings Industry, Inc.:

SP-58 Pipe Hangers and Supports Materials, Design and Manufacture.
SP-69 Pipe Hangers and Supports Selection and Application

C. Appliances and materials governed by UL requirements shall meet such requirements and bear the label.

1.4 QUALITY ASSURANCE

A. Provide adequate supervision of labor force to assure that all aspects of the specifications are being fulfilled.

B. Verify that all work and equipment is installed in accordance with manufacturer's warranty requirements.

PART 2 PRODUCTS

2.1 STEEL PIPE AND FITTINGS

A. Water Piping:

1. ASTM A53 seamless, Schedule 40.

2. Fittings up to 2 inch shall be 150 lb. malleable iron, screwed pattern ASME B16.3. Butt weld , ASME B16.9, same thickness as pipe.

3. Fittings 2-1/2" and larger shall be butt weld ASME B16.9, same thickness as pipe.

4. Weld-O-Lets and Thread-O-Lets shall be maximum of two sizes smaller than main size; i.e., maximum of a 2-inch Weld-O-Let on a 3-inch pipe.

5. Thread tape shall be teflon tape, 3 mils minimum thickness.

2.2 COPPER TUBING & FITTINGS

A. Refrigeration Piping:

1. Copper tubing: Type ACR, hard drawn temper.

2. Fitting: Wrought-copper, solder joints, ASME B16.22 or ASME B16.26.

3. Joints: Brazed, American Welding Society (AWS) Class BCUP-5 for brazing filler metal.

B. Water Piping:

1. Tubing: Hard drawn seamless ASTM B-88 Type "L" aboveground.

2. Soft seamless ASTM B-88 Type "K" below-ground.

3. Joint Material: Brazed joints, low temperature silver-bearing solder.

   a. Flux shall be non-toxic type and non-corrosive.

4. Fittings: ASME B16.15, B16.18, B16.22, or B16.26.

C. Condensate Drain Piping:

1. Pipe: Copper tubing Type DWV.

2. Fittings: Wrought copper solder type drainage fittings, ASME B16.23 or B16.29.

2.3 STRAINERS

A. Perforations: .033" pipe size to 2", .057" pipe size 2-1/2" to 4".

B. Self-cleaning "Y" type screwed end up to 2 inch with machined seats with blow-off outlet, stainless steel screen, iron body.

C. Self-cleaning "Y" type flanged 2-1/2 inch and up, with bolted cover flange, blow-off outlet, 125 psi ANSI, brass screen.

2.4 THERMOMETERS

A. Separable socket, inserted into fluid flow, adjustable, hermetically sealed, red or blue indicating fluid, non-toxic, die-cast, baked enamel finish, double strength glass lens, white scale and black graduations.

B. Scale: Heating Water - 30 deg. to 240 deg. F

C. Manufacturer: U.S. Gauge, H.O. Trerice, Moeller,

2.5 GAUGES

A. Phosphor bronze bourdon tube, polypropylene case, gasketed glass crystal, aluminum dial, black graduations 4-1/2 inch diameter.

B. Range: 0 to 60 psi, 5 pound intervals, 1/2 pound graduations.

C. Manufacturers: Danton, U.S. Gauge, H.O. Trerice, Moeller.

D. Install with bronze gauge cock.

2.6 TEST STATIONS - PRESSURE/TEMPERATURE

A. Provide a SISCO 1/4" or 1/2" NPT fitting (Test Plug) of solid brass at desired indicated locations. Test plug shall be capable of receiving either a pressure or temperature probe 1/8" o.d. Dual seal core shall be neoprene for temperature to 200 degrees F. Nordel to 350 degrees F and shall be rated zero leakage from vacuum to 1000 psig. P/T plug to have grooved cap and chain.

B. P/T plugs shall be provided with extensions as required by insulation.

C. Mechanical Contractor shall also provide the following: pressure gauge adapters with 1/8" o.d. probe, 5" stem pocket testing thermometers for 25 degrees to 125 degrees F (tower and chilled water)

for 0 degrees to 220 degrees F (hot water) for 50 degrees - 500 degrees F (temperatures above 220 degrees F).

D. One (1) Master Test Kit shall be furnished to the Owners. Kit shall contain one (1) 2-1/2" test gauge of suitable range, one (1) Gauge Adapter 1/8" o.d. probe, and 5" stem pocket testing thermometers - one (1) 0 degree - 220 degrees F and one (1) 50 degree - 550 degree F.

E. Manufacturer: Sisco P/T Plugs.

2.7 ISOLATING FITTINGS

A. Provide isolating fittings between all sections of dissimilar piping materials or piping and equipment where one material is ferrous and the other is non-ferrous.

B. Manufacturer: Epco Sales, Inc., or insulated unions by Central Plastic Co.

2.8 PIPE SADDLES

A. Steel pipe saddles shall be welded to all black ferrous pipe, 2-1/2" pipe size and larger, at hanger locations, for systems of steam, hot water and other heat conveying systems.

B. Steel pipe saddles shall be welded to all black ferrous hot piping at the pipe support location when roll type hangers or pipe roll supports are employed.

C. The saddles shall be packed with plastic insulating cement, and the saddle shall finish flush with the surface of the specified insulation.

2.9 ANCHORS AND GUIDES

A. Anchors and guides shall be provided to support and maintain pipes in position and properly distribute expansion. The anchors and guides must be securely fastened to the building structure, and must be completely installed before the system is tested.

B. Factory made cast semi-steel or fabricated steel, consisting of a bolted two-section outer cylinder and base with two-section guiding spider bolted or welded tight to the pipe.

C. Guide and spider shall be of sufficient size to clear pipe insulation and long enough to prevent over travel of spider and cylinder. Guides shall not be used as pipe supports.

D. Guides shall be as manufactured by J.J. McNally, Inc., Flexonics, Inc., Metraflex, Hyspan, Twin City Hose, Inc.

2.10 EXPANSION COMPENSATORS

A. All heating and/or cooling system piping shall contain expansion compensators to compensate for expansion and/or contraction resulting from temperature variations. These lines shall have adequate guides and anchors as defined by the Expansion Joint Manufacturer’s Association (EJMA) Standards.

B. Bellows construction shall be multi-ply laminated corrugated bellows of Type 300 stainless steel.

C. All compensators shall have a square telescoping shroud to prevent torsional stress and/or external damage.

D. End fittings shall be suitable for male pipe thread, female pipe thread, female copper tube, weld end, 150# flange and mating piping.

E. Compensators for heating system piping shall be designed for 2" total travel (1-1/2" compression, ½" extension) for single units, 4" total travel (3" compression, 1" extension) for dual units. Compensators for chilled water systems shall be designed for 1" extension and 1" compression (single units) and 2" extension and 2" compression (dual units) respectively.

F. Units shall be as manufactured by Flex-Weld Keflex Model 7Q, Metraflex Products, Flex Hose Co., Twin City Hose, Inc.

2.11 FLEXIBLE EXPANSION LOOP (MANUFACTURED)

A. Provide flexible expansion loops of size and type noted on drawings.

B. Flexible expansion loops shall consist of two (2) flexible sections of hose and braid, two 90° elbows, and a 180° return assembled in such a way that the piping does not change direction, but maintains its course along with a single axis.

C. Flexible expansion loops shall have a factory supplied, center support nut located at the bottom of the 180° return, and a drain/air release plug.

D. Flexible expansion loops shall impart no thrust loads to system support anchors or building structure. Loops shall be installed in a neutral, pre-compressed or pre-extended condition as required for the application. Install and guide per manufacturer's recommendations.

E. Materials of construction and end fitting type shall be consistent with pipe material and equipment/pipe connection fittings.

F. Manufacturers: Metraflex Company, Metraloop.

2.12 UNIONS

A. Up to and including 2 inch pipe size: Screwed pattern, bronze-to- bronze seat.

B. Above 2 inch pipe size: Flanged pattern, A.S.A. forged steel, with gaskets, bolts and nuts.

C. Copper tubing unions shall have sweated type ends. Flanged unions on copper tubing may be soldered connections.

D. Materials and pressure ratings shall be the same as specified for the respective pipe and fitting system unless otherwise specified.

2.13 MOTORS

A. All single phase and polyphase motors shall be manufactured to incorporate the latest NEMA standards.

B. All single phase and polyphase motors shall have steel frames with ball bearings and copper windings. All motors to have a Class "F" insulation system with a service factor of 1.15.

C. All motors shall be 1725 RPM, 4 pole design, unless otherwise noted on the drawings, or in the equipment specifications.

D. Motors installed indoors and not exposed to moisture shall be open, dripproof, Class B temperature rise based on 40 deg. C maximum ambient temperature.

E. Motors installed outdoors and exposed to moisture shall be totally enclosed, fan cooled, Class B temperature rise based on 40 deg. C maximum ambient temperature.

G. Motor Characteristics: Refer to Equipment Schedules for specific data.

277/480 Volt System: Motors 1/2HP & Larger - 480V, 3 Phase, 3 Wire
Motors Less than 1/2HP-120/277V, 1 Phase, 2 Wire.

H. All motors rated less than 1/2HP shall have thermal protection of the auto-reset type as an integral part of the motor.

I. All motors rated 1/2HP and larger shall have thermal protection provided by an external device.

PART 3 EXECUTION

3.1 PIPING SYSTEMS

A. All piping to drain to low points. Low points shall be provided with drain valves with hose thread.

B. All piping shall be arranged to have air vents at high points.

1. Air vents shall be automatic in operation when located in Boiler Rooms and Mechanical Equipment Rooms. All air vents shall be provided with a PVC drain line which shall be routed to the nearest floor drain. Several air vents may be tied together.

2. Air vents shall be manual in operation in all other locations.

C. Do not install trapped lines where water cannot be drained or air can accumulate without being vented.

D. Piping shall run square with building lines.

E. Piping shall not be insulated or covered until tested and until building is enclosed.

F. Necessary drains, off-sets, vents and drips shall be provided for coordination of the work as part of the contract.

G. Running or close nipples are not permitted.

H. Piping shall not be installed over electrical transformers, panels, switchgear, substations, and control panels. No piping shall be installed in elevator machine rooms.

I. Exposed insulated piping risers in unfinished spaces shall be covered with 22 gauge galvanized steel sleeves from floor to ceiling. Refer to Section: Insulation & Covering – HVAC for additional requirements.

J. Allow clearance for expansion and contraction.

K. Install eccentric piping fittings where change in sizes occurs in piping systems. Tops of pipes to remain level.

L. Install isolating fittings between sections of ferrous and non-ferrous pipe or connected equipment.

M. Do not support piping from other piping, conduits or equipment.

N. Strainers shall be installed on suction of all pumps, inlets of control valves, and where indicated on drawings.

O. Thermometers and gauges shall be installed where indicated on the drawings, required by equipment specifications and where indicated elsewhere in the specifications.

P. Flexible connectors shall be provided on suction and discharge piping of all base mounted pumps.

Q. Unions shall be provided adjacent to all valves, at equipment connections, and where necessary to facilitate dismantling of the piping system.

R. Install expansion joints, expansion compensators, anchors and guides in piping systems as shown on the drawings and in accordance with manufacturer's written instructions.

1. Provide anchors and guides on both sides of the expansion compensator, or expansion joint in accordance with EJMA Standards.

2. Provide anchors and moment guides in each pipe, with the first moment guide located the equivalent of four-pipe diameters from the compensator, and the second guide fourteen pipe diameters beyond the first guide.

3. Remove all shipping blocks, stays, setscrews, etc., from all compensators and moment guides. Pipe centerlines shall be aligned.

4. During initial system pressurization, all pipe guides and anchors must be secure and functioning.

S. Material Requirements for Systems:

1. Heating Hot Water Supply & Return Piping:
   a. Schedule 40 black steel.
   b. Type L hard copper.

2. Make-up Water: Type L hard copper.

3. Condensate Drain
   a. Type DWV copper.

4. Refrigerant Piping: Type ACR hard copper.

3.2 TAGS, CHARTS AND IDENTIFICATION

A. See Paragraph "Labeling" in GENERAL PROVISIONS for equipment labeling.

B. Identify each valve in all systems with black, numbered and stamped 1- 1/2" brass or aluminum tags fastened to valve by brass chain and S-hook.

C. Provide 1/8" scale diagrams showing location, number and service or function of each tagged item.

1. Frame diagrams in approved metal frames with clear acrylic front, hinges, and locks.

2. Secure to wall in Mechanical Room.

3. Provide two additional separate copies permanently covered and bound.

   a. Include one (1) copy in the Operation and Maintenance Manuals.

D. Piping Identification: Identify piping with Seton "Setmark" or Brimar, semi-rigid plastic, wraparound pipe markers with flow arrows and conforming to ANSI A13.1. Locate marker at each valve, changes in direction, where pipes pass thru barriers and every 25' of horizontal runs. Lettering on background shall be in accordance with the following colors:

Legend		Background	Lettering
1.	Gas	- Yellow	- Black
2	Heating Supply	- Yellow	- Black
3	Heating Return	- Yellow	- Black
4	Cold Water	- Green	- White
5	Condensate	- Yellow	- Black

F. Manufacturers: Seton “Setmark”,

3.3 WELDING

A. All concealed and inaccessible black steel piping shall be welded.

B. All black steel piping larger than 1-1/4 inch may be fusion welded.

C. All elbows, tees and branch connections shall be made with welding fittings ANSI B16.9.

D. Welding shall be in accordance with the ASME Boiler and Pressure Vessel Code Section IX.

E. Furnish welder test certificate for review. Certificates of successful qualification by the following organizations shall be acceptable.

1. ASME Boiler and Pressure Vessel Code

2. ANSI Code for Pressure Piping

3. National Certified Pipe Welding Bureau

4. Military Specification MIL-STD-248

3.4 SOLDERING/BRAZING

A. Connections between copper tubing and copper fittings shall be made with the appropriate filler metal. Flux shall be non-corrosive type as recommended by the manufacturer of the filler metal, and conforming to AWS A5.8.

B. Tubing shall be cut square and then reamed and deburred. End of tubing and inside of fitting cup shall be cleaned with steel wool and the flux shall be applied to the clean surface before joining. After joining, the excess filler metal shall be wiped off while still plastic.

C. Silver brazing alloy shall be equal to Easy-Flo by Handy and Harmon or Sta-Brite silver solder and shall be used for joints in:

1. Hot water heating piping

2. Air conditioning drain piping

3. Cold water fill and make-up piping

D. Where the silver brazing is performed in a confined non-ventilated space, a non-toxic, cadmium-free brazing alloy such as braze 560 by Handy & Harman shall be used.

E. Refrigerant piping shall be silver brazed using Harris Sil-Fos 15 or equivalent, with nitrogen purge.

F. Bring joint to solder temperature or brazing temperature in as short a time as possible.

G. Form continuous solder bead or brazing filler bead around entire circumference of joint.

H. Wipe excess solder from joint area while solder is still plastic.

END OF SECTION 230210

SECTION 230215: VALVES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.

B. Refer to Section 230200 for HVAC General Provisions.

C. Refer to other sections in Division 23 for materials and methods not specified herein.

1.2 DESCRIPTION OF WORK

A. This Section includes the following:

1. General
2. Hot Water Heating System
3. Refrigerant Valves and Specialties

1.3 QUALITY ASSURANCE

A. Provide adequate supervision of labor force to assure that all aspects of the specifications are being fulfilled.

B. Verify that all work and equipment is installed in accordance with manufacturer's warranty requirements.

PART 2 PRODUCTS

2.1 GENERAL

A. All gate and globe valves shall be designed for repacking under pressure when fully opened, and shall be equipped with packing suitable for the intended service. When the valve is fully opened, the back seat shall protect the packing and the stem threads from the fluid. All gate and globe valves shall have a gland follower. The pressure- temperature rating of valves shall be not less than the design criteria applicable to all components of the system.

B. Insofar as possible, all valves of the same type shall be of the same manufacture.

E. Manufacturers:

Apollo
Watts
Nibco

2.2 HOT WATER HEATING SYSTEM

A. Gate Valves - 2" and smaller:

Valves 2" and smaller shall be of Class 150 with body and union bonnet of ASTM B-62 cast bronze composition, threaded or solder ends, solid disc, copper-silicon stem, brass packing gland, Teflon- impregnated packing, and malleable handwheel.

B. Ball Valves - 3" and smaller:

Valves 3" and smaller shall be 600 psi CWP, have cast brass bodies, replaceable reinforced Teflon seats, conventional port, blowout proof stems, chrome plated brass ball, and threaded or solder ends with extended solder cups.

Drain valves, ½” or ¾”, shall be 600 psi CWP, with stainless steel trim, cast bronze body, 2-piece with cap and chain, full port stainless steel ball and stem, RTFE ball seat, threaded or soldered inlet connection, cap rated for 150 psi.

C. Gate Valves - 2-1/2" and larger:

Valves 2-1/2" and larger shall be Class 125 iron body, bronze mounted, with body and bonnet conforming to ASTM A-126 Class B cast iron, flanged ends, with Teflon-impregnated packing and two-piece packing gland assembly.

D. Globe Valves - 2" and smaller:

Valves 2" and smaller shall be of Class 150 with body and union bonnet of ASTM B-62 bronze, copper-silicon alloy stem, brass packing gland, Teflon-impregnated packing and malleable handwheel.

E. Globe Valves - 2-1/2" and Larger:

Valves 2-1/2" and larger shall be Class 125 body, bronze mounted, with body and bonnet conforming to ASTM A-126 Class B cast iron, flanged ends, with Teflon - impregnated packing and two-piece packing gland assembly.

G. Check Valves - 2" and smaller:

Valves 2" and smaller shall be Class 150 with bodies and caps of ASTM B-62 bronze composition and threaded ends. Class 150 valves shall have lift-type Buna-N-disc and union caps, and are to be used in lines with globe valves.

For backflow prevention in lines with gate valves, Y-pattern valves with swing-type disc are recommended.

H. Check Valves - 2-1/2" and Larger:

Valves 2" and larger shall be iron body, bronze mounted, with body and cap conforming to ASTM A-126 Class B cast iron, flanged ends, and swing-type disc.

2.3 REFRIGERANT VALVES & SPECIALTIES

A. Service Valves:

1. Globe Shutoff Valves: Forged brass, packed, back seating, winged seal cap, 300 degrees F (149 degrees C) temperature rating, 500 psi working pressure.

2. Check Valves: Forged brass, accessible internal parts, soft synthetic seat, fully guided brass piston and stainless steel spring, 250 degrees F (121 degrees C) temperature rating, 500 psi working pressure.

3. Manufacturers:

   Henry Valve Co.
   Parker Hannifin Corp., Refrigeration & Air-Conditioning
   Sporlan Valve Co.

B. Solenoid Valves:

1. 2-way Solenoid Valves: Forged brass, designed to conform to ARI 760, normally closed, teflon valve seat, NEMA 1 solenoid enclosure, 24-volt, 60 Hz., UL-listed, 1/2" conduit adapter, 250 degrees F (121 degrees C) temperature rating, 400 psi working pressure.

2. Manufacturers:

   Alco Controls Div., Emerson Electric Co.
   Automatic Switch Co.
   Sporland Valve Co.

C. Specialties:

1. Refrigerant Strainers: Brass shell and end connections, brazed joints, monel screen, 100 mesh, UL listed, 350 psi working pressure.

2. Moisture-Liquid Indicators: Forged brass, single port, removable cap, polished optical glass, solder connections, UL listed, 200 degrees F (93 degrees C) temperature rating, 500 psi working pressure.

3. Refrigerant Filter-Driers: Steel shell, ceramic fired desiccant core, solder connections, UL listed, 500 psi working pressure.

4. Evaporator Pressure Regulators: Provide corrosion-resistant, spring loaded, stainless steel springs, pressure operated, evaporator pressure regulator, in size and working pressure indicated, with copper connections.

5. Refrigerant Discharge Line Mufflers: Provide discharge line mufflers as recommended by equipment manufacturer for use in service indicated, UL listed.

6. Manufacturers:

   Alco Controls Div., Emerson Electric Co.
   Henry Valve Co.
   Sporlan Valve Co.

PART 3 EXECUTION

3.1 PIPING SYSTEMS

A. All piping to drain to low points. Low points shall be provided with drain valves with hose thread.

B. Valve body construction shall match piping system material.

C. Install isolating fittings between sections of ferrous and non-ferrous pipe or connected equipment.

D. Valves shall be installed with stems above horizontal.

E. Valves shall be installed on all sides of equipment and control valves to allow isolation for repair.

F. Unions shall be provided adjacent to all valves, at equipment connections, and where necessary to facilitate dismantling of the piping system.

3.2 TAGS, CHARTS AND IDENTIFICATION

A. Identify each valve in all systems in accordance with requirements of Section 230210.

END OF SECTION 230215

SECTION 230230: INSULATION & COVERING - HVAC

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the contract, including the conditions of the contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.

B. Refer to Section 230200 for HVAC General Provisions

C. Refer to Section 230210 for HVAC Basic Materials & Methods.

1.2 DESCRIPTION OF WORK

A. This Section includes insulation and covering provided on the following piping and equipment:

1. Hot Water Heating Piping
2. Condensate Drain Lines
3. Refrigerant Piping.
4. Hot equipment surfaces.
5. Exterior Piping

B. Insulation shall be installed on the following duct systems:

1. All supply ductwork.
2. All return ductwork.
3. All outside air intake and relief ductwork.

1.3 REFERENCE STANDARDS

A. Refer to Section 230200 for a general description of requirements applying to this section.

1.4 QUALITY ASSURANCE

A. Refer to Section 230210 for a general description of requirements applying to this section.

B. Install insulation in accordance with manufacturer's recommendations.

C. Provide adequate supervision of labor force to assure that all aspects of the specifications are being fulfilled.

1.5 SUBMITTALS

A. Submit shop drawings, installation instructions, and manufacturer's literature of all materials specified in accordance with Section 230200.

B. Submit fabrication instructions for pipe fitting and valve insulation.

C. Submit manufacturer's joining recommendations for butt joints and longitudinal seams.

1.6 WARRANTY/GUARANTEE

A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, General Requirements.

PART 2 PRODUCTS

2.1 PIPE INSULATION MATERIAL

A. Fiberglass:

1. Material: Preformed fiberglass bonded with resin to form circular pipe sleeves with factory applied, white all service jacket bonded to reinforced foil vapor barrier jacketing. The jacket shall have factory applied double pressure-sensitive, self-sealing adhesive closure and vapor sealing of longitudinal joints. Thermal conductivity: 0.24 Btu/Hr./SF/inch at 100 degrees F. Flame spread of 25 and developed smoke of 50 or less.

2. All Valves and Fittings:

   a. Glass fiber insert and premolded PVC cover, Johns Manville Corp. "Zeston" and "Hi-Lo Temp Inserts" for fittings. Glass fiber must fill the entire space within the cover completely.

   b. Factory molded fibrous glass fitting covering for fittings. Coat ends with Fosters 30-36 lagfast adhesive

   c. Mitered sections of pipe covering for valves.

3. Manufacturers: Johns Manville Corp., Certain-Teed, Owens- Corning, Knauf.

B. Closed Cell:

1. Material: Flexible elastomeric foamed plastic closed cell structure insulation 25/50 rated with a flame spread rating of 25 or less and a smoke developed rating of 50 or less.

2. Flexible pipe insulation shall be a foamed plastic closed cell structure material, with a thermal conductivity of not more than 0.27 Btu/Hr./Sq. Ft./Inch at a mean temperature of 75 degrees F. The insulation shall have an average density of at least 2 pounds per cubic foot, shall be self-extinguishing, and shall have a water vapor transmission rating of not more than 0.1 perms. Between temperature limits of -40 degrees F and plus 220 degrees F, the insulation shall not indicate any deviation from its original state.
3. Specification Compliance:

   ASTM-E-84
   ASTM-C-534 Type I – Tubular, Type II – Sheet.
   ASTM-D-1056, 2B1 – Tubular, Sheet.
   MIL-C-3133B (MIL STD 670B) Grade SBE-3
   MIL-P-15280J, Form T, Form S.

4. Manufacturers: Armacell, Nomaco K-Flex, Halstead.

C. Covering of Pipe Insulation Outdoors:

1. Wrapping: Wrap insulation with embossed 0.016" aluminum jacket.

2. Fastenings: Cover shall be held in place with soft aluminum bands on 12" centers.

3. Valves and Fittings: Weatherproof all valves and fittings.

D. Manufacturers: Johns Manville Corp., Certain-Teed, Owens- Corning, Knauf.

2.2 DUCT INSULATION

A. Concealed Supply, Return, Relief, and Outside Air Ductwork and all ductwork connected to energy recovery units: Fiberglass duct wrap bonded with resins, 3/4 pound density, aluminum foil facing reinforced with fiberglass scrim, laminated to Kraft, 2" thick.

1. Thermal Conductivity: 0.27 Btu/Hr./SF/Inch at 75 degrees F. Min. installed "R" value w/25% compression shall be 5.6.

2. Duct wrap shall be cut to stretch-out dimensions as provided in manufacturer's instructions. Remove a 2" piece of insulation from the facing at the end of the piece of insulation to form an overlapping staple and tape flap. Install with facing outside so tape flap overlaps insulation and facing at other end. Insulation shall be tightly butted and not compressed excessively at duct corners. Seams shall be stapled 6" on center with outward clinching staples. All seams, tears, punctures and other penetrations of the insulation facing shall be sealed with foil tape or vapor proof mastic. Where rectangular ducts are 24" in width or greater, duct wrap shall be secured to the bottom of the duct with mechanical fasteners; i.e., stick pins spaced 18" on center.

B. Exposed supply, return, relief, and outside air ductwork, shall be insulated in finished conditioned spaces, penthouse, mechanical rooms, mezzanine areas, equipment closets, and non-conditioned spaces with 2" thick rigid fiberglass board. Insulation shall be 6 P.C.F. density with a "K" value of 0.25 Btu/Hr./SF/Inch at 75 degrees F. mean temperature and shall be U.L. listed at 25 maximum for flame spread, and 50 maximum for smoke developed. Insulation shall be applied using Graham Pins or Stik-Clips and all seams, edges and breaks shall be sealed with 4" matching tape and sealed with Vicryl CP-10 to match ASJ jacket. Insulation shall be provided with all-service jacket facing.

C. Manufacturers: Johns Manville Corp., Certain-Teed or Owens- Corning, Knauf.

D. Outdoor Installation:

1. Pre-manufactured panel system consisting of four (4) piece interlocking panels.

2. The interlocking panels shall be constructed of Dow Thermax Polyisocyanurate insulation, ASTM D-1622, nominal 2 pcf; water vapor transmission as permeance less than 0.03, per ASTM E-96; water absorption less than 0.3% (24 hours), per ASTM C-209; flexure strength more than 40 psi, per ASTM C-203.

3. Operating temperature range of -100°F to +250°F.

4. Insulation shall be laminated in two (2) layers to provide R-14 at 2" thickness, per ASTM C-236/C-518.

5. The insulation shall be jacketed with 0.032" thick embossed aluminum and sealed with vapor barrier compound. All joints shall interlock to ensure a thermal seal.

6. Panels shall be secured with #10 self-tapping stainless screws with weather seal washers.

7. Manufacturers: Techna-Duc Insulation System as made by P.T.M. Manufacturing, L.L.C., Newark, Delaware.

2.3 CALCIUM SILICATE INSULATION

A. Material: Insulation for hot equipment shall be heavy density fiberglass insulation retained by .016" aluminum held in place by 1"x25 gauge stainless steel bands spaced on a maximum center distance of 12". All joints and voids shall be filled with insulating cement, well trowelled into the openings. Cleanouts, manholes and nameplates shall not be insulated, and the insulation shall be neatly beveled off at such openings.

B. Thickness: 3-1/2" thick.

K Factor @ 200 deg. F = 0.38 – Surface Temperature 87°F
K Factor @ 600 deg. F = 0.90 – Surface Temperature 112°F

C. Equipment Included:

1. Steam or Hot Water Convertor or Heat Exchanger
2. Field Fabricated Boiler Breaching
3. High Temperature Water (up to 250°F) Storage Tanks.
4. Steam Condensate Receivers.
5. Steam Flash Tanks.

D. Manufacturers: Industrial Insulation Corp.

2.6 REUSABLE VALVE COVERS

A. All valves, strainers, combination valves, etc. in chilled water and heating hot water systems shall be insulated with a factory fabricated removable and reusable cover.

B. Insulation shall be either fiberglass blanket or flexible elastomeric thermal insulation as listed in Paragraph 3.2 of this specification. Flame and smoke spread shall be 25/50 per ASTM 84.

C. Outer jacket shall be made of material equal to Tychem QC, overlap and completely cover the insulation, with seams joined by tabs made from Velcro or fabric straps per manufacturer's standards.

D. Outer jacket shall overlap adjoining sections of pipe insulation, and shall be non-combustible, impermeable to water, and prevent mold, mildew and condensation.

E. Installation shall not require the use of any special hand tools.

F. Manufacturers: Corick Valve Covers, NoSweat Valve Wraps.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

A. Do not install until systems have been tested and meet requirements.

B. Do not install until building is enclosed.

C. Heavy work which may damage insulation shall have been completed in the vicinity of the insulation work.

D. Provide non-compressible insulation saddles at all piping hanger locations, and at all piping hanger locations where piping is insulated with flexible closed cell insulation.

Option: Provide insulation coupling system as made by Klo-Shure Co.

E. All installations shall be made by skilled craftsmen regularly engaged in this type of work.

F. Insulation shall be continuous thru-wall, ceiling and floors.

G. Metal shields, 16 gauge galvanized, shall be installed between hangers and pipe insulation.

H. Pipe, ductwork and equipment shall be clean and dry prior to insulating.

I. Install all insulation per manufacturer's instructions.

J. To avoid undue compression of insulation, provide solid core inserts at all supports as recommended by the insulation manufacturer. Provide insulation shields between the insulation jacket and the hanger.

K. Ductwork treated with internal acoustic duct liner does not require external insulation.

3.2 PIPE INSULATION - TYPES & THICKNESSES

A. Provide fiberglass insulation of thickness specified on:

1. Heating Hot Water: (Up to 200°F)

1-1/2" for piping 1-1/2" and below
2" for pipes 2" and over.

B. Provide flexible closed cell insulation of thickness specified on:

1. Refrigerant Piping: Exterior Locations for suction lines. (NOTE: Insulate liquid line if metering device is mounted at the condensing unit.)

   1-1/2" thick for all piping

2. Cold surfaces of refrigeration equipment, air separators for heating hot water, and hot water pumps. 3/4" thickness

3. Hot water expansion tanks. 3/4" thickness

4. 1” thickness for all water piping within terminal unit cabinets.

5. 1/2" thickness for condensate drain lines.

3.3 PIPE COVERING (FOAMED PLASTIC TYPE)

A. All joints and seams shall be sealed with a compatible adhesive. Approved adhesives are as follows:

Armstrong World Industries No. 520
Benjamin Foster Company No. 85-75 up to 200 degrees F.

Contractor may use Armstrong Self-Seal Armaflex 2000 insulation in lieu of the above wherever 1/2" is specified.

B. Fitting covers shall be fabricated from the foamed plastic pipe insulation or from sheet insulation of the identical material. The fabrication shall be in accordance with manufacturer's instructions, and all seams mitered joints shall be joined using the adhesives described hereinbefore.

C. Pipe insulation in concealed spaces shall require no finish coatings.

D. Pipe insulation in all other areas shall receive two coats of finish of color selected by Architect. Approved finishes are as follows:

Armstrong World Industries WB Armaflex Finish

3.4 EXTERIOR PIPE COVERING

A. Wrapping: Wrap insulation with embossed 0.016" aluminum jacket, orient seam down.

B. Fastenings: Cover shall be held in place with soft aluminum bands on 12" centers.

C. Valves and Fittings:

1. Weatherproof all valves and fittings.
2. Finish: Apply two coats of vapor resistant mastic reinforced with glass fabric over wrapping.

3.5 INTERIOR PIPE COVERING

A. Provide premolded PVC cover on all interior insulated piping exposed in finished spaces. Orient seams up in overhead piping and toward the wall in vertical runs.

B. Provide factory molded fitting covering for fittings and accessories, sealed and held in place by manufacturer's recommended sealing system.

C. Provide mitered sections of covering for valves.

END OF SECTION 230230

SECTION 230300: VIBRATION AND SOUND ISOLATION - HVAC

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the contract, including the conditions of the contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.

B. Refer to Section 230200 for HVAC General Provisions

C. Refer to Section 230210 for HVAC Basic Materials & Methods.

1.2 DESCRIPTION OF WORK

A. This Section includes providing the following vibration and sound isolation material on items furnished and installed under HVAC work:

1. Inertia pads
2. Piping, Inline Pumps

1.3 REFERENCE STANDARDS

A. Refer to Section 230200 for a general description of requirements applying to this section.

1.4 QUALITY ASSURANCE

A. Refer to Section 230210 for a general description of requirements applying to this section.

1.5 SUBMITTALS

A. Submit shop drawings, installation instructions, and manufacturer's literature of all materials specified in accordance with Section 230200.

B. Submit the following:

1. Shop drawings
2. Product data

1.6 WARRANTY/GUARANTEE

A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, General Requirements.

PART 2 PRODUCTS

2.1 GENERAL

A. All vibration control apparatus shall be furnished by a single recognized manufacturer. The manufacturer shall submit to the Architect/Engineer evidence affirming that he has been a supplier of vibration control devices of the type required for the past five years.

B. Unless otherwise indicated or specified, all equipment mounted on vibration isolator bases shall have a minimum operating clearance of 1 inch between the base and the floor or housekeeping and beneath. Clearance space shall be checked to insure that no scrap, rubbish, hardware, etc., has been left to possibly short circuit isolated base.

C. In connecting isolated HVAC equipment to rest of system, care must be exercised to insure proper installation.

1. Equipment connected to water piping shall be erected on isolators or isolated foundations to correct operating height prior to making piping connections to avoid misalignment problems. To facilitate this, equipment shall be blocked-up with temporary shims to final operating height. When full load is assembled and water is in system, isolators shall then be adjusted to take up load just enough to allow removal of shims.

D. Vibration isolator sizes and location shall be determined by the vibration control products manufacturer or as specified herein.

2.2 ISOLATOR TYPES

A. Inertia Pads:

1. Frame to be structural steel with built-in height saving bracket for recessing into a CPF concrete inertia block for side access.

2. Spring to be adjustable, free-standing, open-spring mounting with combination leveling bolt and equipment fastening bolt. The spring shall be rigidly attached to the spring mounting baseplate and compression plate. The isolator shall be designed for a minimum Kx/Ky (Horizontal-to-Vertical spring rate) of 1.0. A neoprene pad having a minimum thickness of 1/4" shall be bonded to the baseplate. Amber/Booth Type CPF with RSW-1.

B. Piping in Mechanical Room, In-Line Pumps:

1. Type PBSR: for first two hangers in horizontal piping adjacent to isolated equipment and for all hangers on 8" and larger pipe, except the first two hanger points adjacent to riser shall be Type BS.

2. Type BSR for remaining hangers in horizontal piping.

3. Type SW for pipe risers. Isolator base plates shall be provided with holes for bolting and isolation grommets.

4. Type SW for floor supports except Type CT for first floor support adjacent to equipment isolated on CT isolators.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's specifications and instructions.

1. No metal-to-metal contact will be permitted between fixed and floating parts.

2. Connections to Equipment: Allow for deflections equal to or greater than equipment deflections. Electrical, drain, piping connections, and other items made to rotating or reciprocating equipment (pumps, compressors, etc.) which rests on vibration isolators, shall be isolated from building structure for first three hangers or supports.

3. Common Foundation: Mount each electric motor on same foundation as driven machine. Hold driving motor and driven machine in positive rigid alignment with provision for adjusting motor alignment and belt tension. Bases shall be level throughout length and width. Provide shims to facilitate pipe connections, leveling and bolting.

4. Provide heat shields where elastomers are subject to high temperatures.

5. Extend bases for pipe elbow supports at discharge and suction connections at pumps. Pipe elbow supports shall not short circuit pump vibration to structure.

6. Non-rotating equipment such as heat exchangers and convertors shall be mounted on isolation units having the same static deflection as the isolation hangers or support of the pipe connected to the equipment.

7. Ensure that the outer surface of the equipment or duct is clean and free of dust, dirt or similar foreign matter. If desired, the outside surface can be painted with a rust-resistant paint in order to minimize potential corrosion.

   a. Field cut and apply the insulation decoupler to the outside of the duct. Obtain a uniform thickness by butting all seams together (do not overlap). At elbows or similar transitions, field measure and miter cut the insulation to fit. Ensure that the insulation is not compressed by the fastener used, if any.

   b. Wrap the noise barrier around the equipment housing or insulation-wrapped duct. At all seams, overlap the barrier by a minimum of 2” and adhere using adhesive. Alternately, the barrier can be butted together at joints with the seam covered by a 2” (50 mm) wide cut piece of the barrier material. This strip is then adhered to the barrier on either side of the seam using adhesive.

   c. If desired, metal or nylon bands can be wrapped around the outside of the barrier to guard against the potential of adhesive failure. If used, this banding should be placed on either side of all radial seams in addition to the midpoint on longer sections. Ensure that the banding is snug only and does not result in compression of the insulation decoupler beneath.

d. In lieu of banding, insulation "stick pins" can be used to reinforce the seams in the noise barrier. Ensure that the pin does not compress the insulation or barrier material beneath.

B. Inspection and Adjustments: Check for vibration and noise transmission through connections, piping, ductwork, foundations, and walls. Adjust, repair or replace isolators as required to reduce vibration and noise transmissions to specified levels.

END OF SECTION 230300

SECTION 230400: HEATING GENERATION EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.

B. Refer to Section 230200 for HVAC General Provisions.

C. Refer to Section 230210 for HVAC Basic Materials and Methods.

D. Refer to Section 230230 for Insulation and Covering – HVAC.

1.2 DESCRIPTION OF WORK

A. This Section includes labor, material, equipment necessary to provide a complete boiler system as specified herein and shown on the drawings:

1. Boilers – (Condensing Type)

B. Refer to other Division 23 sections for related work.

1.3 REFERENCE STANDARDS

A. Refer to Section 230200 for a general description of requirements applying to this Section.

B. See specifications in this Section for specific compliance with I=B=R, NFPA, UL, ASME, etc.

1.4 QUALITY ASSURANCE

A. Refer to Section 230210 for a general description of requirements applying to this section.

B. Quality Assurance:

1. Manufacturers: Firms regularly engaged in manufacture of boilers, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

2. Regulatory Requirements:

a. I=B=R Compliance: Provide boilers that have been tested and rated in accordance with Institute of Boiler and Radiator Manufacturers (I=B=R) "Testing and Rating Standard for Cast Iron and Steel Heating Boilers", and bear I=B=R emblem on nameplate affixed to boiler.

b. NFPA Compliance: Install boilers in accordance with National Fire Protection Association (NFPA) Code 54 "National Fuel Gas Code".

c. NFPA 211 Compliance: Heating equipment burning gas, solid or liquid fuels, Section 60.

d. Underwriter's Laboratories, Inc., (U.L.) file MA 7991 for storage of flammable liquids.

f. ASME, CSD-1

1.5 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 230200.

B. Submit the following:

1. Shop Drawings
2. Product Data
3. Evidence of specified code or other compliance.

1.6 SUBSTITUTIONS

A. The listed equivalent or substituted manufacturers along with the bidding related contractor shall be completely responsible to comply with all requirements on all contract documents. This shall include, but not be limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades, including all required ancillary items furnished and installed by other trades. If the manufacturer or related bidding contractor does not comply with these requirements, this Contractor shall be responsible for any and all additional costs associated with the changes required by other trades.

1.7 WARRANTY/GUARANTEE

A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, GENERAL REQUIREMENTS. In addition, the following special guarantee applies:

1. Start-up and one year of factory service on boilers.

PART 2 PRODUCTS

2.1 BOILER – CONDENSING TYPE

A. Boilers shall be CSA design certified as a condensing boiler. Boilers shall be designed for a minimum of 3:1 continuous turn down with constant CO2 over the turndown range. The boiler shall operate with natural gas or propane and have a CSA certified input rating as noted on the drawings, and a thermal efficiency rating of 85% at rated input and 94.3% at minimum input. The boiler shall be symmetrically air-fuel coupled such that changes in combustion air flow or flue flows affect the BTUH input without affecting combustion quality. The boiler will automatically adjust input for altitude and temperature induced changes in air density. The boiler will use a proven pilot interrupted spark ignition system. The boiler shall use a UL approved flame safeguard ignition control system using UV detection flame sensing. The design shall provide for silent burner ignition and operation. The boiler shall be down fired counter flow such that formed condensate always moves toward a cooler zone to prevent re-evaporation. An aluminum corrosion resistant condensate drain designed to prevent pooling and accessible condensate trap shall be provided.

B. Constuction

1. The boiler shall be constructed in accordance with the latest requirements of the ASME Boiler and Pressure Vessel Code and shall be stamped with ASME Symbol. Maximum boiler working pressure shall be 160 psig at 250°F temperature.

2. The boiler shall be factory assembled and shall be shipped to the job location complete with burner and jacket assembled at the factory and all trim mounted and wired. The complete section assembly shall be hydrostatically pressure tested before shipment in accordance with Section IV of the ASME Boiler and Pressure Vessel Code. The boiler shall be factory fire-tested before shipment and the burners shall provide 12 to 12-1/2% CO_2 with a trace to a No. 1 smoke on the Bacharach scale. Boiler shall be equipped with lifting lugs to facilitate lifting and positioning of the boiler.

3. The water boiler shall be provided with built-in air elimination system to assure positive separation of air from circulating water. The water boiler shall be constructed to provide balanced water flow through the entire section assembly so that single supply and return connections can be employed.

4. The boiler shall be provided with an insulated heavy gauge steel jacket with durable baked enamel finish. The jacket shall be easily removable and insulated with minimum 1-1/2" thick foil backed, fiber glass on the front, back, top and side panels.

5. The boiler shall be furnished with a factory mounted burner assembly with a refractory mounting plate which shall be provided with the necessary holes and tappings to mount the burner, including ceramic port if required. The burner backing plate shall be fixed or hinged for access to the furnace.

6. Service Access: The boiler shall be provided with access covers for easily accessing all serviceable components. The boiler shall not be manufactured with large enclosures, which are difficult to remove and reinstall. All access must seal completely as not to disrupt the sealed combustion process. All components must be accessible and able to adjust with the removal of a single cover or cabinet component.

7. Indicating lights: Include a diagnostic control panel with a full text display indicating the condition of all interlocks and the BTUH input percentage. Access to the controls shall be through a completely removable cover leaving diagnostic panel intact and not disrupted.

C. Boiler Trim:

1. Boiler Controls:

   a. The boiler shall be furnished with operating limit, and safety high limit (manual reset) temperature control. The low temperature limit control shall be set according to the design of the heating system.

   b. The boiler shall be furnished with a 3-1/2" dia. combination pressure- temperature gauge to indicate boiler water temperature, system pressure.

   c. The boiler shall be furnished with an ASME certified pressure relief valve and the valve shall

be set to relieve at pressure schedule on the drawings. The relief valve shall be of the side outlet discharge type. The relief valve outlet shall be piped to a floor drain per applicable building codes.

d. All electrical safety boiler controls are to be of accepted quality manufacture bearing U.L. certification.

e. The Boiler shall be furnished with a U.L. certified low water fuel cut-off. The low water fuel cut-off shall have an ASME working pressure rating of at least the ASME working pressure of the boiler. The low water fuel cut-off shall be installed according to the manufacturer's instructions.

2. Burner: (Boiler Manufacturer’s Standard)

a. The packaged, liquid propane gas (LP) shall be U.L. certified and shall be of a design which produces flame retention with rapid intimate mixing of the fuel and combustion air. The burner shall be designed to insure high efficiency and good performance under either balanced draft or forced draft venting conditions.

b. The burner shall be arranged for modulating operation with pre-purge, low fire start, post-purge and air control. The burner shall be furnished with a pre-wired NEMA 1 control panel which incorporates an annunciating type electronic combustion control with display, electronic flame detector with UV sensor, control circuit transformer, alarm bell with silence switch, flame failure, low water alarm relays and motor starter, electronic combustion safeguard burner primary control, electronic flame detector with UV sensor and motor starter relay. The burner shall be factory fire-tested to ensure proper operation before shipment.

3. Gas valve train: Refer to detail on the drawings.

a. Gas train shall meet UL 795, CSD-1 requirements.

b. Pilot Gas Train (Mounted, Piped and Wired): A separate pilot gas cock, gas pressure regulator and pilot safety shutoff gas valve shall be provided for the ignition gas supply.

D. Boiler shall be provide with the following options:

1. Aluminum Condensate Receiver Pan
2. Low Air Pressure Switch
3. Blocked Flue Detection Switch
4. Manual Reset Low Water Cut Off (CSD-1 Factory Mounted and wired)
5. Modulation Control
6. Temperature/Pressure Gauge
7. Manual Reset High Limit
8. Air inlet filter
9. Inlet/Outlet Temperature Display
10. Full Digital Text Display for all Boiler Series of Operation and Failures
11. Variable Frequency Drive and Combustion Air Fan
12. Condensate Drain
13. Air Inlet hood for exterior termination of air intake pipe.
14. Vent termination hood for exterior termination of vent pipe.

E. Guarantee: The boiler shall be provided with start-up by factory trained personnel and a full one year factory service to begin at start-up. The boiler shall be warranted for a minimum of twenty (20) years against thermal shock damage, non-pro-rated.

F. Manufacturers: Aerco, Lochinvar Corp.

1. Any listed equivalent manufacturer and the Mechanical Contractor shall be completly responsible to comply with all requirements on the contract documents. This shall include, but not be limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades.

PART 3 EXECUTION

3.1 BOILER-BURNERS

A. Install per Manufacturer's Written Instructions:

1. Properly level.

2. Set bottom of framework on concrete pad. The Contractor shall construct level concrete pad and foundations according to the manufacturer's erecting instructions. Mount boilers on 4" high concrete pads. Provide pads, with beveled edges.

3. Pipe all relief valves, blowoffs and drains to the floor drains. Pipe size shall not be less than tapping on boiler, low water cutoff, etc.

4. Adequately protect boiler-burner unit during construction.

5. Pipe all gas vents to exterior in accordance with CSD-1 and utility company requirements. Terminate with screened vent head.

6. Insulate all factory installed piping for hot water, steam and condensate as applicable.

B. Start-up, Contractor shall:

1. Employ the services of approved water treatment consultant who shall:

a. Test water before filling boiler and prescribe proper water treatment to prevent corrosion or deterioration due to oxygen, acid or scaling.

b. Immediately after internal inspection and refilling of boiler, check water conditions at that time and prescribe proper water treatment again.

2. Be responsible for:

a. Supplying and using prescribed ingredients. (initial water treatment)

b. Maintain proper water conditions until acceptance of boiler. After acceptance of boiler, water treatment will be provided by the Owner.

c. Cleaning systems as specified.

d. Not filling boiler until firing equipment is operable.

3. As soon as boiler is filled, ready for testing, or final acceptance.

C. Testing and Cleaning:

1. Bring water up to 210°F and circulate for two hours to drive off air.

2. Demonstrate all safety devices in presence of Owner's Representative and Engineers before final acceptance.

3. Set maximum firing rate of boiler.

4. Skim off impurities until boiler water is clear.

D. Services of Factory mechanic:

1. Arrange to have services of a factory representative trained field mechanic on site to start up the boiler(s).

2. Mechanic shall check out entire installation, including all pumps and feed apparatus and controls, shall start the units into operation and shall make all necessary tests and adjustments to have said equipment operate to his and to the Engineer's satisfaction.

3. Manufacturer shall issue a letter stating that the installation has been checked and adjusted and is ready to turn over to the Owner following the completion of this work.

4. Manufacturer is to forward three (3) copies of the starting reports to the Owner.

5. Factory mechanic shall be at the job for the initial start-up for not less than two (2) consecutive calendar days.

6. Factory mechanic shall conduct demonstration and combustion tests in the presence of the Owner for each boiler for gas firing and oil fire and shall submit written report to the Owner.

7. The same factory mechanic shall make two more trips to the job within the succeeding eight months from the date of the above-mentioned letter for the purpose of further adjusting and checking and shall be immediately available in the event of operating failure of the units within a period of one year from the date of the letter.

E. Tools and spare Parts for Each Boiler: Furnish and obtain receipt for complete set of gaskets, flue brush and scraper with light weight handles and all special tools that may be required.

END OF SECTION 230400

SECTION 230410: HEATING GENERATION AUXILIARY EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.

B. Refer to Section 230200 for HVAC General Provisions.

C. Refer to Section 230210 for HVAC Basic Materials and Methods.

D. Refer to Section 230400 for Heating Generation Equipment.

1.2 DESCRIPTION OF WORK

A. This Section includes labor, material, equipment necessary for a complete boiler system as specified and shown on the drawings:

1. Type B Gas Vent Pipe & Fittings
   Gas Vent Pipe & Pipe Fittings

C. Provision for boiler stack and breeching, or vent and combustion air piping.

D. Refer to other Division 23 sections for related work.

1.3 REFERENCE STANDARDS

A. Refer to Section 230200 for a general description of requirements applying to this section.

1.4 QUALITY ASSURANCE

A. Refer to Section 230210 for a general description of requirements applying to this section.

B. Quality Assurance:

1. Manufacturers: Firms regularly engaged in manufacture of equipment types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

2. Regulatory Requirements:

   a. NFPA Compliance: Install gas-fired boilers in accordance with National Fire Protection Association (NFPA) Code 54 "National Fuel Gas Code".

   b. NFPA 211 Compliance: Heating equipment burning gas, solid or liquid fuels, Section 60.

   c. Underwriter's Laboratories, Inc., (U.L.) file MA 7991 for storage of flammable liquids.

A. Submit shop drawings and product data in accordance with Section 230200.

B. Submit the following:

1. Shop Drawings
2. Product Data
3. Evidence of specified code or other compliance.

1.6 SUBSTITUTIONS

A. The listed equivalent or substituted manufacturers along with the bidding related contractor shall be completely responsible to comply with all requirements on all contract documents. This shall include, but not be limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades, including all required ancillary items furnished and installed by other trades. If the manufacturer or related bidding contractor does not comply with these requirements, this Contractor shall be responsible for any and all additional costs associated with the changes required by other trades.

1.7 WARRANTY/GUARANTEE

A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, GENERAL REQUIREMENTS

PART 2 PRODUCTS

2.1 TYPE B GAS VENT PIPE & FITTINGS

A. The gas vent system shall be so engineered and constructed as to develop a positive flow adequate to exhaust all flue gases to outside atmosphere, without condensation within the vent or spillage at any appliance draft hood.

B. All parts of vent system shall be of Underwriters' Laboratories, Inc., listed Metal-Fab Type B double wall gas vent piping, and such piping shall be continuous from the appliance outlets into Metal-Fab vent top.

C. The Metal-Fab gas vent piping shall be installed in full compliance with the terms of its listing, with the manufacturer's installation instructions, and with nationally recognized building codes representing good practice for such installations.

D. It shall be the responsibility of the prime contractor to provide adequate accessibility, head room, and chase dimensions so that all vent connections and vertical vents can be correctly sized, spaced and supported.

E. Manufacturers: Metal-Fab, American Metal Products, Heat Fab, Inc., Selkirk Metalbestos or Z-Flex.

2.2 GAS VENT PIPE & FITTINGS

A. The gas vent system shall be so engineered and constructed as to develop a positive flow adequate to exhaust all flue gases to outside atmosphere, without condensation within the vent.

B. All parts of vent system shall be of Underwriters' Laboratories, Inc., listed Metal-Fab Type CORR/Guard Model CG, double wall gas vent piping, and such piping shall be continuous from the appliance outlets into Metal-Fab vent terminal. Venting System shall be rated at 6” W.C. and tested to 15” W.C. per UL Standard 1738.

C. The Metal-Fab gas vent piping shall be installed in full compliance with the terms of its listing, with the manufacturer's installation instructions, and with nationally recognized building codes representing good practice for such installations.

D. For vent sizes 6” to 12” inside diameter, inner wall thickness shall be 0.015”, Type AL29-4C stainless steel.

Outer casing shall be 0.018”, aluminized steel.

E. Inner and outer walls shall be connected by means of spacer clips that maintain concentricity of the annular space and allow differential thermal expansion of the inner and outer walls.

F. All supports, wall penetration, terminal with miter cut and birdscreen, boiler connector and condensate drain fitting shall be included.

G. All joints shall be sealed using manufacturer’s approved sealant. Joints exposed to the weather shall be sealed to prevent rainwater from entering the annular space between inner and outer walls.

H. Provide adequate accessibility, head room and dimensions so that all vent connections can be correctly sized, spaced and supported.

I. Manufacturers: Metal-Fab, Metalbestos, Heat Fab, Inc., American Metal Products.

PART 3 EXECUTION

3.1 BOILER BREECHING (FIELD FABRICATED)

A. Boiler breeching shall be installed in accordance with the latest IMC Code.

END OF SECTION 230410

SECTION 230500: PIPING SYSTEMS & ACCESSORIES - HVAC

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the contract, including the conditions of the contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.

B. Refer to Section 230200 for HVAC General Provisions

C. Refer to Section 230210 for HVAC Basic Materials & Methods.

1.2 DESCRIPTION OF WORK

A. This Section includes the following equipment:

1. In-Line Circulator Pumps
2. Diaphragm-Type Expansion Tanks
3. Air Separators
4. Balancing Valves
5. Flexible Pump Connectors
6. Automatic Flow Control Valves

1.3 REFERENCE STANDARDS

A. Refer to Section 230200 for a general description of requirements applying to this section.

1.4 QUALITY ASSURANCE

A. Refer to Section 230210 for a general description of requirements applying to this Section.

B. Whenever a variable frequency PWM drive is installed to control an AC motor, a maintenance-free, circumferential, conductive micro fiber shaft grounding ring shall be installed on the AC motor drive end to discharge shaft currents to ground. Recommended part: AEGIS SGR™ Bearing Protection Ring, as made by Electro Static Technology. Install in accordance with the manufacturer's written instructions.

1.5 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 230200.

B. Submit the following:

1. Shop Drawings
2. Manufacturers Product Data
3. Test Reports on Piping System Tests

1.6 SUBSTITUTIONS

A. The listed equivalent or substituted manufacturers along with the bidding related contractor shall be completely responsible to comply with all requirements on all contract documents. This shall include, but not be limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades, including all required ancillary items furnished and installed by other trades. If the manufacturer or related bidding contractor does not comply with these requirements, this Contractor shall be responsible for any and all additional costs associated with the changes required by other trades.

1.7 WARRANTY/GUARANTEE

A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, General Requirements.

PART 2 PRODUCTS

2.1 IN-LINE CIRCULATOR PUMPS

A. Provide in-line circulator pumps where indicated, and of capacities as scheduled.

B. End suction with vertically split casing, close coupled, single stage, designed for 175 psi working pressure.

C. Cast iron body, 125 psi ANSI flanges of equal size, tappings for gauge and drain fittings.

D. Steel shaft with replaceable shaft sleeve and standard mechanical seal with ceramic seal seat.

E. Enclosed type impeller hydraulically and dynamically balanced, keyed to shaft and secured with locking screw.

F. Manufacturers: Subject to compliance with requirements, provide pumps of one of the following:

Armstrong Pumps
Bell & Gossett
Peerless
Taco

2.2 DIAPHRAGM-TYPE EXPANSION TANKS

A. Fabricate tank of continuously welded steel plate of the size shown conforming to ASME Section VIII Standards, maximum working pressure of 125 psi.

B. Provide air charging valve, drain-offs, system connection and other piping connections. Paint outside of tank with a zinc chromate primer.

C. Provide a standard cleanout hole located in the tank head.

D. Tank shall have a sealed-in heavy-duty butyl diaphragm suitable for operation from 40 to 240 degrees F.

E. Tank shall be furnished with an ASME stamp.

F. The tanks shall be manufactured by Amtrol, Bell and Gossett, Patterson, Taco, Wheatley, John Wood.

2.3 AIR SEPARATORS

A. Furnish and install, as shown on plans, a centrifugal type air separator. The unit shall have NPT or flanged inlet and outlet connections tangential to the vessel shell. Vessel shell diameter to be three times the nominal inlet/outlet pipe diameter.

B. The unit shall have an internal stainless steel air collector tube with 5/32" diameter perforations and 63% open area designed to direct accumulated air to the compression tank via an NPT connection at top of unit.

C. The unit shall have a removable galvanized steel system strainer with 3/16" diameter perforations and a free area of not less than five times the cross-sectional area of the connecting pipe. A blowdown connection shall be provided to facilitate routine cleaning of the strainer.

D. Manufacturer to furnish data sheet specifying air collection efficiency and pressure drop at rated flow.

E. A manufacturers' Data Report for Pressure Vessels, Form U-1 as required by the provisions of the ASME Boiler and Pressure Vessel Code shall be furnished for each air separator upon request.

F. Manufacturers:

Armstrong
Bell & Gossett
Thrush Div., Amtrol, Inc.

2.4 BALANCING VALVES

A. Balancing valves to be installed where indicated.

B. Furnish and install, as shown on the plans, balancing valves with provision for connecting a portable differential (Ft. of Head) pressure meter. Each meter connection shall have pressure/temperature readout ports.

C. The balancing valves shall be Y-pattern style design and all metal parts of non-ferrous, pressure die-cast, nonporrous Ametal copper alloy. Each valve can be installed in any direction without affecting flow measurement and shall provide four (4) functions:

1. Precise flow measurement
2. Precision flow balancing
3. Positive shut-off with no drop seat and teflon disc

4. Drain port suitable for hose bib fitting.

D. The valves shall have four (4) 360 deg. adjustment turns of handwheel for maximum setting with hidden memory feature to program the valve with precision tamperproof balancing setting.

E. Design Pressure/Temperature:

1/2" - 3" NPT connections 300 psig at 250 deg. F.
1/2" and 3/4" sweat connections 200 psig at 250 deg. F.
4" flanged connections 125 psig at 250 deg. F.

F. Flow sensor: For installation in piping 5” and larger, a precision wafer type orifice insert installed between standard 125 psi at 250 deg. F ANSI flanges to monitor system flow; cast iron body with integral brass EPT check valves to accommodate a differential pressure meter; furnish with calibrated nameplate with flow range through a range of differential head pressures; provide globe valve at each sensor to adjust flow to design conditions.

G. Manufacturers: Tour & Anderson, Armstrong, Bell & Gossett, Taco, Wheatley.

2.5 FLEXIBLE PUMP CONNECTORS

A. Flexible hose connectors shall be provided on suction and discharge piping of all base-mounted pumps. The flexible connectors shall be spring steel wire reinforced rubber compound in accordance with the following descriptions.

B. Construction: The flexible connectors of reinforced rubber compound shall be a compression molded elastomer material with wire and rayon cord reinforcing and designed for a service temperature of 240 degrees F and a minimum pressure of 150 psi. Screwed end type shall have metal screwed connections molded into the elastomer material. Flanged units shall be one-piece construction whereby the elastomer material is molded to form the flanges.

D. Manufacturers: Mason Industries, Moyno-RKL, Amber Booth, Metraflex, Patterson, Proco Products, Inc., Twin City Hose, Inc.

2.6 AUTOMATIC FLOW CONTROL VALVES

A. Design:

1. Automatic flow control valves shall be factory set and shall automatically limit the rate of flow to within 5% of the specified amount. For 1/2" - 2-1/2", the flow cartridge shall be removable from the valve body to provide access for regulator changeout, inspection and cleaning without breaking the main piping. (Access shall be similar to that provided for removal of a Y-strainer screen.) Each valve shall have two P/T ports. All automatic flow control devices shall be supplied by a single source and certified tests witnessed by a Professional Engineer shall be available.

2. Sizes 1/2" thru 2": Autoflow "AC" automatic flow regulator valves incorporating ball valve, union and two pressure temperature plugs. Valve to be bronze and flow regulator cartridge to be

accessible without disturbing piping. On the supply side of the coil, install an Autoflow "YC" combination Y-strainer with ball valve, union/ P/T port and ball valve blowdown.

B. Construction:

1. All internal parts of the valve shall be brass, nickel or stainless steel for corrosion and wear resistance.

2. For 1/2" through 2-1/2" pipe sizes: Brass Y-type body. Connections shall be sweat or threaded to match piping system specified.

C. Minimum Ratings: 1/2" through 2-1/2" pipe size - 400 psig at 275 deg. F.

D. Flow Verification: The flow shall be verified by measuring the differential pressure across the coil served or the wide open temperature control valve and calculating the flow using the coil or valve Cv.

E. Test Kit: A differential pressure test kit shall be supplied to verify flow and measure overheating. The kit shall consist of a 4-1/2" diaphragm gauge equipped with ten foot hoses and P/T adapters all housed in a vinyl case. Calibration shall be 0-35 psid for 2-32 psi spring range or 0 - 65 psid for 5 - 50 psi range.

F. Manufacturers: Flow Design, Inc.

PART 3 EXECUTION

3.1 CIRCULATING PUMPS

A. Pump shall be installed in accordance with recommendations of the Hydraulic Institute.

B. Suction reducers shall be eccentric and located at the pump suction. Discharge increasers shall be concentric and located at the pump discharge.

C. Suction and discharge piping shall be adequately supported without imposing any load on the pump casing.

D. Pressure gauges shall be installed at the suction and discharge of each pump.

E. Vibration isolation equipment shall be provided where noted.

F. Impeller diameter used shall be approximately 85% of the maximum impeller diameter capable of being supplied for each pump.

H. The motor nameplate horsepower shall not be exceeded under any conditions of pump operation.

I. Prior to shipment, each pump shall be tested to insure its capability to produce the required capacity at the design head, and when requested written verification of this test shall be supplied.

J. Before grouting and piping the pump, the Contractor shall check to insure pump alignment is satisfactory, and where required, realign the pump. Fill baseplate with non-shrink grout to the top of the base rail.

K. Start-up service shall be provided by the pump manufacturer or his representative. This service shall include the following:

1. Check alignment
2. Check absence of pipe strain
3. Check lubrication
4. Check rotation
5. Take suction and discharge pressure gauge readings and compare with pump nameplate for operating head.
6. Take voltage and current readings and compare with motor nameplate.
7. Insure proper maintenance manuals are available if required.

3.2 BYPASSES

A. Three-valve bypasses shall be provided in piping at main system control valves, at control valves for heat exchangers, domestic hot water generators, central station air handling units, and where indicated on drawings.

B. The bypasses shall consist of two gate valves and one globe or angle valve. The bypass pipe size shall be at least equal to the control valve size.

3.3 PIPING SYSTEM DRAINS

A. All piping shall be graded or pitched toward drain locations which shall be provided with gate valve unless otherwise indicated on drawings or specified. Individual risers may be drained through removable plugs or caps.

B. Drain valves shall be provided at all major components in systems including boilers, pumps, heat exchangers, cooling towers, and similar equipment.

3.4 ECCENTRIC PIPE FITTINGS

A. Eccentric pipe fittings shall be furnished and installed in all piping and circulated water piping where a change in pipe size occurs in a horizontal run. In water systems the top of the adjacent pipe sections shall be maintained level.

3.5 CHEMICAL CLEANING

A. New boilers shall be boiled out with an alkaline type boiling out compound to remove grease, oil, mil scale and other foreign matter. The compound should be used at the rate of 1-1/2 pounds per 20

boiler horsepower. After the boiling out period, the boiler shall be completely drained, flushed and refilled with fresh water.

B. Closed recirculating systems shall be filled and sufficient detergent and dispersant added to remove all dirt, oil and grease. System shall be circulated for at least 48 hours after which a drain valve at the lowest point shall be opened and allowed to bleed while the system continues to circulate. The automatic make-up valve shall be checked to be sure it is operating. Bleeding shall continue until water runs clear and all detergent is removed. A sample of water shall be tested and if pH exceeds 8.0, draining should be resumed.

C. Drain all detergent solution from system piping and equipment to nearest floor drain or indirect waste point connected to the building's sanitary system.

END OF SECTION 230500

SECTION 230510: WATER TREATMENT (HVAC)

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The general provision of the contract, including the conditions of the contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.

B. Refer to Section 230200 for HVAC General Provisions.

C. Refer to Section 230210 for HVAC Basic Materials & Methods.

1.2 DESCRIPTION OF WORK

A. This Section includes labor, material, equipment and supervision to provide a complete water treatment system for the following:

Cleaning and treatment of circulating HVAC chilled water system, hot water and steam system.

1. Cleaning Compounds.
2. Chemical Cleaning of New Systems

1.3 REFERENCE STANDARDS

A. Refer to Section 230200 for a general description of requirements applying to this section.

B. Requirements established within the portions of the Project Manual titled Division 1, General Requirements, are collectively applicable to the work of this section.

C. Technical Services: Provide the services of an experienced water treatment chemical engineer or technical representative to direct flushing, cleaning, pre-treatment, training, debugging, and acceptance testing operations; direct and perform chemical limit control during construction period and monitor systems for a period of 12 months after acceptance, including not less than four service calls and written status reports. Minimum service during construction/start-up shall be 8 hours.

D. Field Quality Control and Certified Laboratory Reports: During the one year guarantee period, the water treatment laboratory shall provide not less than 12 reports based on on-site periodic visits, sample taking and testing, and review with Owner, of water treatment control for the previous period. In addition to field tests, the water treatment laboratory shall provide certified laboratory test reports. These monitoring reports shall assess chemical treatment accuracy, scale formation, fouling and corrosion control, and shall contain instructions for the correction of any out-of-control condition.

E. Log Forms: Provide one year supply of preprinted water treatment test log forms.

1.4 SUBMITTALS

In accordance with Section 230200 provide the following:

A. Manufacturer's Literature and Data:

1. Cleaning compounds and procedures.

2. Chemical treatment for closed systems.

B. Water analysis verification.

C. Materials Safety Data Sheet for all proposed chemical compounds.

D. Maintenance and operating instructions.

PART 2 PRODUCTS

2.1 CLEANING COMPOUNDS:

A. Alkaline phosphate or non-phosphate detergent/surfactant/specifically to remove organic soil, hydrocarbons, flux, pipe mill varnish, pipe compounds, iron oxide, and like deleterious substances, with or without inhibitor, suitable for system wetted metals without deleterious effects.

B. Refer to Section, PIPING SYSTEMS & ACCESSORIES - HVAC, PART 3, for flushing and cleaning procedures.

2.2 CHEMICAL TREATMENT FOR CLOSED LOOP SYSTEMS:

A. Inhibitor: Provide sodium silicate, sodium nitrite/borate, or other approved proprietary compound suitable for make-up quality and make-up rate and which will cause or enhance bacteria/corrosion problems or mechanical seal failure due to excessive total dissolved solids. Shot feed manually. Maintain inhibitor residual as determined by water treatment laboratory, taking into consideration residual and temperature effect on pump mechanical seals.

B. pH Control: Inhibitor formulation shall include adequate buffer to maintain pH range of 8.0 to 10.0.

C. Performance: Protect various wetted, coupled, materials of construction including ferrous, and red and yellow metals. Maintain system essentially free of scale, corrosion, and fouling. Corrosion rate of following metals shall not exceed specified mills per year penetration; ferrous, 0.5; brass, 0.2; copper, 0.15. Inhibitor shall be stable at equipment skin surface temperatures and bulk water temperatures of, respectively, not less than 250 and 125 degrees Fahrenheit. Heat exchanger fouling and capacity reduction shall not exceed that allowed by fouling factor 0.0005.

D. Pot Feeder: By-pass type for chemical treatment schedule 10 gauge heads, 3/4-inch system connections and large neck opening for chemical addition. Feeder shall be bypass filter feeder, minimum five gallon, installed per detail on the drawings, for chilled water system, and for hot water system.

E. Water Analysis: Confirm raw water analysis or provide analysis if none is furnished.

Description	Year (Avg.)
Silica ($Si0_2$)	_____

Insoluble _____

Iron & Aluminum _____

Calcium (Ca) _____

Magnesium (Mg) _____

Sodium & Potassium (Na & K) _____

Carbonate (CO_3) _____

Bicarbonate (HCO_3) _____

Sulfate (SO_4) _____

Chloride (Cl) _____

Nitrate (NO_3) _____

Turbidity _____

pH _____

Residual Chlorine _____

Total Alkalinity _____

Non Carbonate Hardness _____

Total Hardness _____

Dissolved Solids _____

Fluorine _____

F. Conduct performance test to prove capacity and performance of treatment system.

Raw water total hardness, ppm.

Concentration cycles.

Raw water, pH.

System water, pH.

Chemical solution used.

Acid solution used, obe.

Quantity or chemical solution injected into system per cycle.

Quantity of acid injected into system per cycle.

Make up water required.

Waste to drain requirement.

G. Recommended Conditions

1. Buffered Nitrite:

   a. For temperatures 140□F to 180□F - 1000 ppm as sodium nitrite.

2. Molybdate:

   a. 50 - 100 ppm as molybdate (chilled water).

3. pH - 7.0 to 10.0

2.7 CHEMICAL CLEANING OF NEW SYSTEMS

A. Boil out boilers with an alkaline type boiling out compound to remove grease, oil, mill scale and other foreign matter. Compound should be used at the rate of 1-1/2 lbs. per 20 boiler HP. After boiling out period, completely drain, flush and refill boiler with fresh water.

B. Fill closed recirculating systems and add sufficient detergent and dispersant to remove all dirt, oil and grease. Circulate system for at least 24 hours, after which open a drain valve at lowest point, open the make-up water valve and allow to bleed while system continues to circulate. Check the automatic make-up valve to be sure it is operating. Bleeding shall continue until water runs clear and all detergent is removed. Test sample of water and if pH exceeds the pH of the makeup water, flushing shall be resumed.

C. Drain all detergent solution from system piping and equipment to nearest floor drain or indirect waste point connected to the building's sanitary system.

B. Manufacturers: Environmental Products USA, Inc., Model EPRO-150.

PART 3 EXECUTION

3.1 INSTALLATION:

A. Delivery and Storage: Deliver all chemicals in manufacturer's sealed shipping containers. Store in designated space and protect from deleterious exposure and hazardous spills.

B. Install equipment furnished by the chemical treatment supplier and charge systems according to the manufacturer's instructions and as directed by the Technical Representative.

C. Perform tests and report results.

D. Instruct owner personnel in system maintenance and operation.

3.2 INSPECTIONS AND MAINTENANCE:

A. Furnish complete inspection and maintenance service on water treatment equipment for a period of one year after completion and acceptance of the water treatment equipment installation. This maintenance service shall begin concurrently with the guarantee. Maintenance work shall be performed by skilled personnel directly employed and supervised by the same company that provided the water treatment equipment specified herein.

B. The maintenance service shall include the following:

1. Monthly systematic examination of equipment.

2. Cleaning, lubricating, adjusting, repairing and replacing of all parts as necessary to keep the equipment in first-class condition and proper working order.

3. Furnishing all lubricant, cleaning materials and parts required.

4. The operational system shall be maintained to the manufacturer's standards specified including any changes and/or adjustments required to meet varying conditions.

5. Provide 24 hour emergency call-back service which shall consist of promptly responding to calls within two hours for emergency service should a shutdown or emergency trouble develop between regular examinations. Overtime emergency call-back shall be limited to minor adjustments and repairs required to protect the immediate safety of the equipment.

6. Service personnel shall report to the owner or his authorized representative upon arrival and again upon completion of the required work. A copy of the work ticket containing a complete description of the work performed shall be given to the owner.

7. The Contractor shall maintain a log in the boiler room and chiller room. The log shall list the date and time of all monthly examinations and all trouble calls. Each trouble call shall be fully described including the nature of the call, necessary correction performed and/or parts replaced.

END OF SECTION 230510

SECTION 230600: AIR DISTRIBUTION & ACCESSORIES - HVAC

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the contract, including the conditions of the contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.

B. Refer to Section 230200 for HVAC General Provisions

C. Refer to Section 230210 for HVAC Basic Materials & Methods.

D. This Contractor shall coordinate with the work of Division 26 and the Fire Alarm System vendor for locations and mounting of all duct smoke detectors. These devices are shown on the Mechanical Drawings for reference only to show the intent of the work. All locations shall be determined based on approved shop drawings from the Fire Alarm System vendor and the Contractor for the work of Division 26, Electrical. Mount smoke detectors in the supply and return air stream at each unit in accordance with NFPA 72.

1.2 DESCRIPTION OF WORK

A. This Section includes labor, material, equipment and supervision to provide a complete air distribution system as specified herein and as shown on drawings.

1. Ductwork – Single Wall, Square and Rectangular
2. Ductwork - Single Wall, Spiral Round
3. Flexible Air Duct
4. Flexible Connections
5. Dampers
6. Fire Dampers
7. Air Diffusers, Registers and Grilles
8. Prefabricated Roof Curbs and Equipment Supports
9. VAV Units with Reheat
10. Louvers
11. Duct Access Doors (Interior)
12. Duct Access Doors (Exterior)

1.3 REFERENCE STANDARDS

A. Refer to Section 230200 for a general description of requirements applying to this section.

B. Requirements established within the portions of the Project Manual titled Division 1, General Requirements, are collectively applicable to the work of this section.

C. IMC (International Mechanical Code).

D. SMACNA (Sheet Metal and Air Conditioning Contractors National Association, Inc.)

E. American Society of Heating, Refrigerating and Air Conditioning Engineers' recommendations in ASHRAE Guide shall apply to this work.

F. ARI Standard 885 - Standard for Estimating Occupied Sound Levels in the Applications of Air Terminals and Air Outlets.

G. UL (Underwriter's Laboratories, Inc.)

H. NFPA 90A shall apply to this work.

I. State Fire Prevention Regulations.

1.4 QUALITY ASSURANCE

A. Refer to Section 230210 for a general description of requirements applying to this Section.

1.5 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 230200.

B. Submit the following:

1. Shop drawings of all sheet metal. Indicate all steel, piping, conduit, and Architectural/Structural features to demonstrate complete coordination. Scale shall not be less than ¼” = 1'-0".

a. Shop drawings shall indicate the sizes and lengths of each section of ductwork as well as all system components such as coils, VAV boxes, access doors, dampers, diffusers and register locations. Also indicate the type of joints used and where internal acoustic lining or insulation, if required, will be utilized.

b. The location of the duct runs and the air outlets shall be closely coordinated with all other trades by the sheet metal contractor to avoid interference. The shop drawings shall show the contact surfaces adjacent to the ducts or air outlets and the space assigned for concealment. The drawings shall indicate principal items of equipment, adjacent piping and conduit, etc., the location of which shall be secured from the contractors of other trades.

c. Sheet Metal Contractor to include resubmissions of the shop drawings to the Engineer. The resubmissions are to include all corrections to previous submissions.

2. Manufacturer's literature and performance data of all equipment and devices.

3. Samples: Furnish color samples, etc., at request of the Architect.

1.6 SUBSTITUTIONS

A. The listed equivalent or substituted manufacturers along with the bidding related contractor shall be completely responsible to comply with all requirements on all contract documents. This shall include, but shall not be limited to space requirements, code clearances, the type, horsepower,

capacities, number and size of services required from other trades, including all required ancillary items furnished and installed by other trades. If the manufacturer or related bidding contractor does not comply with these requirements, they shall be responsible for any and all additional costs associated with the changes required by other trades.

1.7 WARRANTY GUARANTEE

A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, General Requirements.

PART 2 PRODUCTS

2.1 DUCTWORK (SINGLE WALL, SQUARE AND RECTANGULAR)

A. All ductwork shall be fabricated in accordance with SMACNA "HVAC Duct Construction Standards - Metal and Flexible" latest Edition except as described below. The minimum thickness of metal ductwork is 26 gauge. Fabrication requirements shall be based on ductwork subjected to positive or negative pressures of, 3” W.G. Ductwork systems shall be sealed to SMACNA "Seal Class “B”, Standards. Alternatively, "Ductmate" System 45 can be used in accordance with manufacturer's specifications. Drive slip joints are not permitted.

B. Rectangular ducts for 3”,G. or less, positive or negative pressure shall be per SMACNA Table 1-7,. Longitudinal seams shall be Pittsburgh Lock Type L-l per SMACNA Figure 1-5. Transverse joints shall be standing seam type T -15 per Figure 1-4.

1. In the event that material size is not compatible with duct size and segmenting must be utilized to fabricate duct, use SMACNA Figure 1-5, seam L-4 (Standing Seam).

C. Joints:

1. Per SMACNA Transverse Joint Reinforcement Table 1-12, only joints T -22, T -25a, T -25b and Proprietary slip on flanges will be acceptable.
2. Joints T -25a and T -25b that have stress fractures from bending will not be accepted.

3. All joints will have butyl gasket 3/16" thick by 5/8" wide installed per manufacturer's -- installation instructions.

D. Ductwork systems for this standard shall be galvanized sheet steel, commercial quality of lock - forming grade, conforming to ASTM coating standards A-525 or A-527 with coating of designation G-60. For corrosive or moist conditions, use coating designation G-90.

E. The size and configuration of each duct shall be indicated on design drawings. Where thicker sheets or different types of materials are required, they shall be specified on the design drawings or in the project specifications.

F. Aluminum Rectangular Ductwork:

1. Aluminum ductwork shall be two B.& S. gauges heavier than specified for the equivalent width steel ductwork. Bracing, supports and joints shall be as specified for steel ductwork.

2. Aluminum ducts shall be used where the ducts are concealed when exhausting saturated air from dishwashing, showers, outside air intakes and similar designated spaces.

2.2 DUCTWORK (SINGLE WALL, SPIRAL ROUND)

A. Design Pressure: 2”,

B. Leakage: All ductwork shall meet SMACNA Class "A" leak standards.

C. Fabrication:

1. Gauges, reinforcing angles, seams, joints, fabrication methods, installation methods and practices, duct reinforcement, fabricated dampers and devices installed in duct system, fittings, etc., shall conform to the latest editions of SMACNA standards for construction in accordance with requirements indicated in these specifications.

2. Minimum metal gauges shall be 26 gauge (.019). Follow SMACNA Table 3-2A for Positive pressure and Table 3-2B for Negative pressure.

D. Joints:

1. Duct up to 36" diameter - Male/Female beaded slip joint similar to SMACNA Figure 3-2, joint RT-1 or RT-5, as long as it meets the criteria for the system design pressure. Fittings shall be undersized to fit into spiral duct. All joints shall be secured with a minimum of 4 screws on each duct section (equally spaced). Seal joint with an approved sealant compound, continuously applied prior to assembly of joint and after fastening, making certain that the majority of the sealant resides on the interior of the joint.

2. Duct 37" - 60" diameter: Companion angle Vanstone with full face gaskets having bolt holes punched through prior to insertion of bolts. Gasketing shall be 1/8" thick. Joint is per SMACNA Figure 3-2, joint RT -2 and RT -2A.

3. For all dust collection and particulate carrying duct, SMACNA Figure 3-2, joint RT -3 up to 16" diameter and RT -2 or RT -2A are the only acceptable joints. RT -3 joints do not require any additional sealant as long as the band has gasketing installed by manufacturer. Joints RT -2 and RT -2A require full face gaskets having bolt holes punched through prior to insertion of bolts. Gasketing shall be 1/8" thick. There shall be no fasteners penetrating the duct for collection systems.

4. In lieu of beaded slip connections or Vanstone angle ring connections (the above-mentioned joints), there are proprietary connections that may be used, as long as they meet the pressure criteria set forth in this specification.

2.3 KOOL DUCT SYSTEM (Approved Alternate)
A

A. Provide Kool Duct® rigid phenolic insulation panels as made by Kingspan.

B. The system shall be UL listed as a Class 1 air duct to Standard UL 181 in accordance with NFPA Standards 90A and 90B.

C. Fire and smoke classifications shall be less than 25/50 as determined by test methods in UL 723/ASTM E84-08a.

D. Aluminum foil vapor barrier jacket shall be 1 mil thick coated aluminum, with 0.2”x0.2” glass scrim, glass mat rated for 30 lb./3000 ft. 2, and water vapor transmission of 0.02 perm.

E. Rigid phenolic insulation shall be CFC/HCFC-free and have a zero ozone depletion potential rating, with a density range of 3.43 to 3.75 pcf. Cell structural shall be non-wicking and resistant to moisture penetration.

F. Panels shall be able to withstand temperatures from -4 deg. F to +176 deg. F.

G. Panels shall satisfy the requirements of ANSI/ASHRAE/IESNA 90.1 and IECC, latest editions.

H. Panel insulation shall be minimum 7/8” thick, and provide a minimum insulation value of R-6. Thermal conductivity shall be 0.146 Btu-in/hr.-ft^2 deg. F at a mean temperature of 50 deg. F.

I. Panels assembled to form an air duct system shall meet the requirements of SMACNA for allowable air leakage along each section and all joints for pressure classes up to and including 4” W.C.

2.4 FLEXIBLE AIR DUCT

A. Insulated flexible air duct shall be non-metallic. Air duct shall comply with the latest NFPA Bulletin No. 90A and be labeled as Class 0 or 1 Air Duct, U.L. Standard No. 181.

B. Air ducts shall be suitable for working pressure of not less than plus 10.0 and minus 0.5 inches of W.G.

C. Non-metallic air duct shall be two element spiral construction composed of a corrosion resisting metal supporting spiral and a vinyl coated fiberglass base fabric and shall be mechanically interlocked together.

D. Insulation shall be fiberglass flexible blanket with vapor barrier outer jacket of polyethylene or reinforced mylar. Maximum thermal conductance of 0.23 Btu/Hr./SF/Inch at 75 deg. F temperature.

E. Approved manufacturers shall include the Wiremold Company, Flexmaster Ducting Inc., Owens-Corning, Thermaflex Flex Vent.

2.5 DAMPERS

A. Provide where indicated and required to control flow of air and balance system.

B. Round dampers shall be single blade, molded synthetic bearings at each end, 20 gauge galvanized steel, adjusting quadrant and locking device. Round dampers shall be Ruskin Model MDRS25.

C. Rectangular and square dampers shall be opposed blade within 16 gauge galvanized steel channel frame with corner brace, 16 gauge galvanized steel blades; molded synthetic bearings and hex

steel shafts, exposed or concealed linkage, adjustable quadrant and locking device. Dampers shall be Ruskin Model MD35.

D. Approved Manufacturers: Ruskin, Nailor-Hart, Pottorff, , Louvers & Dampers.

2.6 FIRE DAMPERS

A. Fabricate in accordance with NFPA 90A and UL 555.

1. Ceiling Dampers: Galvanized steel, 22 gauge frame and 16 gauge flap, two layers 0.125 inch ceramic fiber on top side with locking clip.

2. Horizontal Dampers: Galvanized steel, 22 gauge frame, stainless steel closure spring, and lightweight, heat retardant, non-asbestos fabric blanket.

3. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for closure under air flow conditions. Configure with blades out of air stream except for 1.0 inch pressure class ducts up to 12 inches in height.

4. Multiple Blade Dampers: 16 gauge galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 x ½ inch plated steel concealed linkage, stainless steel closure spring, blade stops and lock.

5. Fusible Links: UL 33, separate at 160 deg. F with adjustable link straps for combination fire/balancing dampers.

B. Fire dampers of the applicable rating shall be provided at all locations where ductwork penetrates fire-rated walls, ceilings, or floors. Refer to Architectural Drawings.

B. Manufacturers: Ruskin, Louvers & Dampers, Prefco, Metalaire, Pottorff, Greenheck.

2.7 AIR DIFFUSERS, REGISTERS AND GRILLES

A. Air diffusing terminals shall be provided in duct runs on drawings. The diffusers shall properly and uniformly distribute the design air quantity with no objectionable drafts, while maintaining not more than 50 F. P. M. velocity in the occupied portion of the space.

B. Ceiling Diffusers:

1. Square Louvered Diffuser Face:

a. Square housing, welded steel construction core of square concentric louvers, removable at face of diffuser, round duct connection, with borders suitable for lay-in ceiling tile application.

b. Diffuser Patterns: Fixed louver face for 1, 2, 3, or 4 direction air flow, direction indicated on drawings. Each diffuser shall be provided with adjustable control grids.

c. Finish: Matte white finish.

d. Manufacturers: Titus Model TDC.

2. Ceiling Return Register(CR):

a. Ceiling registers shall have a perforated face with 3/16-inch diameter holes on 1/4-inch staggered centers and no less than 51 percent free area. Perforated face shall be aluminum according to the model selected. The back pan shall be one piece stamped heavy gauge steel of the sizes and mounting types shown on the plans and outlet schedule.

b. The finish shall be #26 white. The finish shall be a baked on anodic acrylic paint, with a pencil hardness of HB to H. Inside of back pan shall be painted flat black.

c. Titus Model: PAR

C. Registers & Grilles:

1. Registers and grilles shall be steel construction, fixed single deflection type, with clips and/or flange holes and screws (as required by Architectural finishes) to secure registers to ceiling construction. Face bars shall be inclined 30 degrees. Registers and grilles shall be factory primed and painted with a baked-on white enamel finish.

2. Wall Supply Registers:

a. Provide manufacturer's standard wall registers where shown; of size, shape, capacity, type of materials and components indicated.
b. Register Materials: Steel construction: Manufacturer's standard stamped sheet steel frame and adjustable blades.

c. Register Faces: Vertical Straight Blades: Vertical blades, individually adjustable, at manufacturer’s standard spacing.

d. Register Patterns: Double Deflection: 2 sets of blades in face, rear set at 90 degrees to face set.

e. Register Finishes: Aluminum Enamel: Air-dried aluminum enamel prime finish.

3. Supply Grilles (SG):

a. Aluminum supply grilles shall be available parallel to the long dimension of the grille. All supply grilles shall be constructed with a 11/4-inch wide heavy aluminum border having a minimum thickness of 0.040-0.050 inch. Outer borders shall be assembled and interlocked at the four corners and mechanically staked to form a rigid frame. Screw holes shall be countersunk for a neat appearance.

b. Blades shall be constructed of heavy duty aluminum and shall be contoured to a specifically designed airfoil cross-section to meet published performance data. Where indicated in drawing schedule or plans opposed-blade volume damper shall be constructed of heavy gauge steel or aluminum.

c. The finish shall be #26 white. The finish shall be a baked on anodic acrylic paint, with a pencil hardness of HB to H.

d. Titus model: 272FL

7. Return Grille (RG):

a. Return grilles shall be provide a free area of at least 90%. Outer borders shall be constructed of heavy extruded aluminum with a thickness of 0.040-0.050 inch and shall have countersunk screw holes for a neat appearance. Aluminum grid shall be 1/2 x 1/2 x 1/2 inch.

b. The finish shall be #26 white. The finish shall be a baked on anodic acrylic paint, with a pencil hardness of HB to H.

c. Titus model: 50F

8. Supply, Return, Exhaust and Transfer Grilles (SG, RG, EG & TG):

a. Grilles shall be available parallel to the long dimension of the grille. Construction shall be of steel with a 11/4-inch wide border on all sides. Screw holes shall be countersunk for a neat appearance. Corners shall be welded with full penetration resistance welds.

b. Deflection blades shall be firmly held in place by mullions from behind the grille and fixed to the grille by welding in place. Blade deflection angle shall be available at 35°.

c. The finish shall be #26 white. The finish shall be a baked on anodic acrylic paint, with a pencil hardness of HB to H.

d. Titus model: 300 RL (SG), 355RL(RG, EG, & TG)

D. Manufacturers: Provide diffusers, registers and grilles of one of the following:

Price
Titus
Tuttle & Bailey

2.8 PREFABRICATED ROOF CURBS AND EQUIPMENT SUPPORTS

A. Factory fabricated by the manufacturer of the respective roof-mounted equipment when available and capable of meeting the following requirements:

1. Thermally and acoustically insulated, rubber isolating pads.

2. Built to suit slope of roof and type of roofing; i.e. standing metal seam with integral cant strip and flashing extension.

3. 8” to 11” height unless otherwise indicated.

4. Support rails shall be aluminum, or sheet steel, with continuous wood nailer and removable counterflashing.

B. Curbs shall be a product of a custom manufacture in the following cases:

1. Curbs as specified are not available from the respective equipment manufacturer.

2. Piping or ducts penetrating roof.

3. Prefabricated equipment supports are required.

4. Step flashing assembly, EPDM for normal use and silicone for pipe temperatures above 200°F stainless steel clamp. Suitable for single or multiple pipes.

C. Pipe supports shall be a product of a custom manufacture equal to Pipe Prop as made by JMB Industries.

C. Manufacturers: Pate, Shipman, Custom Curb, Portals Plus, Lloyd Industries, Inc.

2.9 VAV UNITS WITH REHEAT

A. Terminal units designated shall be pressure independent type and of sizes shown on drawings or terminal unit schedule. Units shall have factory catalog performance ratings which conform to CFM., Heating Capacity, Static Pressure discharge and radiated sound power and attenuation designated.

B. Cabinets shall be constructed of not lighter than 22 gauge, zinc-coated steel with factory applied enamel paint finish. Internal surfaces shall be acoustically and thermally insulated with 1 inch glass fiber material surface-treated to prevent erosion and having U.L. approval meeting NFPA 90A.

C. Heating coil shall be copper tube, aluminum fin.

D. Air volume damper shall be constructed to prevent air leakage in excess of 2% of rated air quantity at 1" inlet static pressure.

E. Automatic damper operators shall be factory installed and thoroughly tested for proper performance.

F. Performance of units shall be based on tests conducted in accordance with ASHRAE Standard 36-72 and with ADC Standard 1062R4 with no duct work between the unit discharge and sound room.

G. Units shall be as manufactured by Trane, Titus, Nailor-Hart Industries, Metalaire, Tuttle & Bailey.

2.10 LOUVERS

A. All wall louvers for intake and exhaust shall be stationary stormproof type.

B. Construction shall be of extruded aluminum with 0.081 inch thick blades and frames and all fastening shall be aluminum or stainless steel.

C. An aluminum expanded metal bird screen with frame shall be secured to the rear face of the louver assembly.

D. Depth of the louver frame shall be 4",6",8", 12" unless otherwise indicated.

E. The surface areas shall be:

- factory Kynar finish of color selected by Architect.

F. Manufacturers: Airstream Products Co., Pottorff, Ruskin, Louvers & Dampers.

2.11 MAGNEHELIC GAUGE

A. Magnehelic gauge for measuring the air flow through the hood shall be installed. The gauge shall be diaphragm actuated, shall have 3-7/8" diameter white dial with black figures and graduations, shall have pointer zero adjustment and shall be furnished complete with two static pressure tips, fittings 1/4" metal tubing and means for mounting the gauge. Gauge shall read to .5" water, in .01" divisions as manufactured by Dwyer Instruments, Inc., Series 2000, or Amron.

2.12 DUCT ACCESS DOORS (Interior Locations)

A. SMACNA standard duct access doors shall be fabricated with 22 gauge galvanized steel door and frame with double wall construction.

1. Doors shall be fabricated of aluminum when installed in aluminum ductwork and stainless steel to match special duct systems.

B. Continuous piano type hinge, same material as door.

C. Latches shall be sash type locks equal to Ventlock 100 latches.
1. Doors 16" and under shall have one latch.

2. Doors over 16" shall have two latches.

D. Door seals shall be foam gasket material continuously bonded to perimeter of door frame.

E. Door insulation shall be 1" thick fiberglass, minimum 1.5 pcf density.

F. Doors shall be able to withstand 3" W.C. static pressure up to 12" x 12" in size; 2" W.C. above that size.

G. Makes: Cesco Products, Karp Co., Nailor-Hart Industries, Pottorff, Lloyd Industries, Inc., Ductmate Industries, Inc.

2.13 DUCT ACCESS DOORS (Exterior Locations)

A. Duct access doors shall be fabricated with 20 gauge inner panels and 16 gauge outer panels of galvanized steel. (option: aluminum or bonderized steel)

B. Frames shall be fabricated of extruded aluminum with internal lateral supports.

C. Inner and outer door frames shall provide a non metal-to-metal separation for thermal and air leakage performance at both low and high static pressure differentials. Doors shall swing to insure that they open against air pressure.

D. Door insulation shall be 1" thick 3.0 pcf density fiberglass.

E. Dual acting handles shall secure door against double gasketing that is continuously and mechanically bonded to the door frame.

F. Doors shall be attached to frame with continuous piano hinge secured to the frame with stainless steel rivets.

G. Makes: Cesco Products, Karp Co., Larsen Mfgr.

.PART 3 EXECUTION

3.1 DUCTWORK

A. Dimensions on drawings are inside dimensions. Sheet metal dimensions shall be increased to suit thickness of acoustic duct lining, if applicable.

B. Ducts shall be concealed unless otherwise indicated.

C. Changes in direction shall be made with radius bends or turning vanes.

D. Supports shall be galvanized steel for steel ductwork and aluminum for aluminum ductwork.

E. Locate ceiling air diffusers, registers, and grilles on "Reflected Ceiling Plans". Unless otherwise indicated, locate units in center of acoustical ceiling modules.

F. Do not install ductwork directly above any electrical equipment.

G. Ductwork shall be supported per SMACNA Standards except as follows:

1. Rivet or screw to side of duct when using flat strap hangers. Rivet or screw to bottom of duct when using trapeze hangers.
2. Extend hangers down the side of the duct at least 9"; pass hangers under ducts less than 9" deep.

3. Space hangers not more than 8' on centers for ducts up to 18" wide and 4' on centers for ducts over 18" wide.

4. Wire hangers are not acceptable.

5. Support ductwork from building structure with expansion bolts, rods, steel angles or channels installed to meet existing or new building conditions.

6. Drilling into the roof deck is not permitted.

7. Driving nails into anchors is not permitted.

H. Air Flow Control:

1. Major take-offs: Install volume control dampers.

2. Branches: Install volume control dampers in all branches and at tap in branch take-off connections.

3. Elbows: Use unvaned elbows with throat radius equal to width of duct and full heel radius; provide turning vanes where full throat and heel radius are not possible.

4. Transitions: Make transitions in ducts as required by structural or architectural interferences.

   a. Proportion airways to compensate for any obstructions within duct.

   b. Avoid dead ends and abrupt angles.

   c. Do not exceed 15 degrees slope on sides of transitions.

3.2 LOUVERS

A. When open louvers are provided on a job, and the louver is open on the back, the contractor shall provide a 2" deep drip pan. Pan shall extend the full length of the louver. Drip pan shall be fabricated from a minimum of 24 gauge galvanized sheet steel. Cross break pan for rigidity. All seams to be welded.

B. Drip pans shall be securely fastened to building structure. Do not hang pans from ductwork, piping systems or equipment. Contractor shall submit shop drawings, showing pan detail and methods of support.

3.3 FLEXIBLE AIR DUCT

A. When flexible duct is used for final connection between duct mains on branches and diffusers on registers. The maximum length of flexible ductwork shall be 5'-0" in length.

B. Flexible ductwork shall be properly hung at the tap collar in order to prevent eventual wear and damage to the flexible duct.

C. The ceiling tile system should not be considered a support on which to lay flexible duct. Refer to SMACNA Standards for proper installation.

3.4 DUCT SYSTEM LEAK SEALING

A. Joints in duct systems at duct heaters, air monitors, fire dampers, sound traps, supply air terminals including air handling light fixtures, shall be sealed to prevent air leakage.

B. All duct joints and seams in medium pressure and high pressure duct systems shall be sealed to SMACNA Seal Class" A" Standards to prevent air leakage.

C. In the event there is in excess of 5% air leakage indicated in low pressure duct systems, it shall be the Contractors responsibility to seal the duct system. The amount of sealing necessary shall be that required to obtain the design air quantity at each terminal.

D. Duct sealing shall be by means of high velocity duct sealants such as Hardcast and/or Neoprene gaskets. Type of sealant and method of application shall conform to recommendations in SMACNA high velocity duct construction standards.

3.5 DUCTWORK TESTING

A. The following ductwork shall be pressure leak tested:

1. Supply ductwork
2. Return ductwork
3. Exhaust ductwork
4. Outside air intake ductwork

B. All tests shall be conducted in accordance with AABC National Standards.

C. Ducts to be tested at 100% maximum of static pressure before any duct is insulated externally and concealed in accordance with SMACNA Standards.

D. Calculate the allowable leakage using leakage factor of 5% of Design Air Flow.

E. Select a limited section of duct for which the estimated leakage will not exceed capacity of the test apparatus.

F. Connect the blower and flow meter to the duct section and provide temporary seals at all openings of the ductwork.

G. Start the blower motor with the inlet damper closed. Increase pressure until the required level is reached.

H. Read the flow meter and compare the leakage in cfm. Reading should be 5% or less of design flow for the duct segment being tested.

I. If reading is more than 5% of design flow, depressurize duct, repair all leaks and retest until 5% or less of design flow is obtained.

J. Complete test reports and obtain Owner's witness signature.

K. Remove all temporary blanks and seals.

L. Warning: Do not overpressure duct.

3.6 EQUIPMENT

A. Test apparatus shall consist of an airflow measuring device, flow producing unit, pressure indicating devices and accessories necessary to connect the metering system to the test specimen.

B. The Contractor conducting tests shall arrange for or provide all temporary services, all test apparatus, all temporary seals and all qualified personnel necessary to conduct the specified testing.

C. Test apparatus shall be accurate within plus or minus 7.5% at the indicated flow rate and test pressure and shall have calibration data or a certificate signifying manufacture of the meter in

conformance with the ASME Requirements for Fluid Meters. Verification of above to be supplied to Owner upon request.

D. Pressure differential sensing instruments shall be readable to 0.05" scale division for flow rates below 10 cfm or below 0.5" w.g. differential. For flows greater than 10 cfm scale divisions of 0.1" are appropriate. U-tube manometers should not be used for reading less than 1" of water.

E. Liquid for manometers shall have a specific gravity of 1 (as water) unless the scale is calibrated to read in inches of water contingent on use of a liquid of another specific gravity, in which case the associated gauge fluid must be used.

F. Instruments must be adjusted to zero reading before pressure is applied.

3.7 TEST REPORT

A. Log the project and system identification data.

B. Enter the fan CFM, the test pressure, and the leakage class specified by the designer.

C. Enter an identification for each duct segment to be tested.

D. Calculate the allowable leakage factor. Enter this number on the report for each test segment.

E. Conduct and record the field tests. If the sum of the CFM measured is less than or equal to the sum of the allowable leakage, the test is passed. Record the date(s), presence of witnesses and flow meter characteristics.

F. Maintain a mechanical duct plan of all tested duct segments. Plan to include duct segment identification and dates tested.

G. Test reports shall be submitted as required by the project documents.

3.8 LABELING

A. At all fire damper, smoke damper and combination fire/smoke damper locations, access doors in ductwork shall be identified with a permanent placard of red-white-red laminated commercial grade plastic construction, minimum one-half inch high capital letters, reading, "FIRE DAMPER", "SMOKE DAMPER", "FIRE/SMOKE DAMPER" as appropriate for the installation. Attach securely to face of access door with brass screws at each corner, sealed airtight.

END OF SECTION 230600

SECTION 230605: FANS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the contract, including the conditions of the contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.

B. Refer to Section 230200 for HVAC General Provisions

C. Refer to Section 230210 for HVAC Basic Materials & Methods.

1.2 DESCRIPTION OF WORK

A. This Section includes labor, material, equipment and supervision to provide a complete air distribution system as specified herein and as shown on drawings.

1. Recessed Ceiling Fan
2. Roof-Mounted Exhaust Fans

1.3 REFERENCE STANDARDS

A. Refer to Section 230200 for a general description of requirements applying to this section.

B. Requirements established within the portions of the Project Manual titled Division 1, General Requirements, are collectively applicable to the work of this section.

C. IMC (International Mechanical Code)

D. SMACNA (Sheet Metal and Air Conditioning Contractors National Association, Inc.)

E. American Society of Heating, Refrigerating and Air Conditioning Engineers' recommendations in ASHRAE Guide shall apply to this work.

F. UL (Underwriter's Laboratories, Inc.)

G. NFPA 90A shall apply to this work.

H. State Fire Prevention Regulations.

1.4 QUALITY ASSURANCE

A. Refer to Section 230210 for a general description of requirements applying to this Section.

1.5 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 230200.

B. Submit the following:

1. Shop drawings of all sheet metal. Indicate all steel, piping, conduit, and Architectural/Structural features to demonstrate complete coordination. Scale shall not be less than 1/4" = 1'-0".

2. Manufacturer's literature and performance data of all equipment and devices.

1.6 SUBSTITUTIONS

A. The listed equivalent or substituted manufacturers along with the bidding related contractor shall be completely responsible to comply with all requirements on all contract documents and as described within the specifications. This shall include, but shall not be limited to space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades, including all required ancillary items furnished and installed by other trades. If the manufacturer or related bidding contractor does not comply with these requirements, they shall be responsible for any and all additional costs associated with the changes required by other trades.

1.7 WARRANTY/GUARANTEE

A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, General Requirements.

PART 2 PRODUCTS

2.1 RECESSED CEILING FAN

A. Recessed ceiling fan shall consist of a rectangular steel cabinet enclosing a true centrifugal fan directly driven by an electric motor.

B. Cabinet shall be complete with a finished plastic ceiling grille and discharge collar equipped with a backdraft damper, metal or plastic, gravity or spring return.

C. Motor and fan shall be conveniently removable with plug-in power chord.

D. The casing shall be sound attenuated, with minimum ½” thick acoustic lining.

E. Provide electronic speed controller, wall cap, roof terminal, metal grille, isolator package, time delay switch with adjustable relay as scheduled on the drawings.

F. Unit shall be AMCA certified.

G. Manufacturers: Loren-Cook, Penn Ventilator, Greenheck

2.3 ROOF-MOUNTED EXHAUST FANS

A. Aluminum casing shall be heavy gauge, mill finish of spun construction, weatherproof, removable, with aluminum birdscreen.

B. Aluminum centrifugal fan, adjustable V-belt drive selected for 150% of motor ampere rating.

C. Fans shall be quiet operating, selected for sound level below that of the space ventilated.

D. Accessories: Disconnect switch, insulated roof curb.

E. Manufacturers: Penn Ventilator Co., Greenheck, Loren Cook

PART 3 EXECUTION

3.1 FANS, EQUIPMENT AND ACCESSORIES

A. Install in accordance with manufacturer's details and instructions.

B. Mount fan speed control at the fan to facilitate mechanical balancing. Power wiring shall be part of the work of Division 26.

C. Perform field mechanical balancing in accordance with Section 230950: TESTING AND BALANCING OF MECHANICAL SYSTEMS.

D. Install units in accordance with manufacturer’s installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer’s recommended clearances.

E. Support: Install and secure roof curb structure, in accordance with National Roofing Contractor’s Association (NRCA) installation recommendations and shop drawings. Install and secure units on curbs and coordinate roof penetrations and flashing.

END OF SECTION 230605

SECTION 230725: TERMINAL HEATING UNITS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the contract, including the conditions of the contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.

B. Refer to Section 230200 for HVAC General Provisions

C. Refer to Section 230210 for HVAC Basic Materials & Methods.

1.2 DESCRIPTION OF WORK

A. This Section includes work necessary and/or required and materials and equipment for construction of a complete system. Such work includes, but is not limited to the following:

1. Unit Heaters
2. Cabinet Heaters
3. Fin-Tube Radiation

1.3 REFERENCE STANDARDS

A. Refer to Section 230200 for a general description of requirements applying to this section.

1.4 QUALITY ASSURANCE

A. Refer to Section 230210 for a general description of requirements applying to this Section.

1.5 SUBMITTALS

A. Submit shop drawings in accordance with Section 230200.

B. Submit shop drawings and descriptive date for all equipment specified in this section.

1.6 SUBSTITUTIONS

A. The listed equivalent or substituted manufacturers along with the bidding related contractor shall be completely responsible to comply with all requirements on all contract documents. This shall include, but not limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades, including all required ancillary items furnished and installed by other trades. If the manufacturer or related bidding contractor does not comply with these requirements, this Contractor shall be responsible for any and all additional costs associated with the changes required by other trades.

1.7 WARRANTY/GUARANTEE

A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, General Requirements.

PART 2 PRODUCTS

2.1 UNIT HEATERS

A. Propeller type, direct drive, resilient-mounted motor, arranged for horizontal discharge, double-deflection louvers.

B. Tested at 400 psig hydrostatic and 200 psig air under water.

C. Enclosure shall be steel, cleaned, phosphated, primed and finished in baked enamel.

D. Manufacturers: Airtherm Manufacturing Co. Modine, Rittling, Sterling, Trane, Vulcan.

2.2 CABINET HEATERS

A. Provide cabinet heaters including chassis, heating elements, fans, motor and insulation.

B. Chassis: Galvanized steel wraparound structural frame with edges flanged.

C. Insulation: Faced, heavy density glass fiber.

D. Cabinet: Vertical semi-recessed/recessed/surface-mounted model as scheduled on the drawings, 16 gauge four sided overlap front panel with stiffeners. Clean cabinet parts, bonderize, phosphatize, and flow-coat with baked-on primer.

E. Coils: Aluminum fins, copper tubes, mechanically expanded for a permanent bond. Provide manual air vent.

F. Grilles: Intake and outlet grilles shall be integral, stamped 15 degrees deflection.

G. Fans: Provide direct drive centrifugal, forward curved double width fan.

H. Motors: Provide two-speed permanent split capacitor type motors (or variable speed) with integral overload protection and motor cords for plug-in to junction box in unit.

I. Provide HI/LO/OFF fan control (concealed).

J. Manufacturers: Modine, Rittling, Sterling, Trane, Vulcan.

2.3 CONVECTORS

A. Fin-tube heating element shall consist of a single seamless copper tube as the primary heating surface, and rectangular plate type aluminum fins as the secondary heat transfer surface. The fins shall be mechanically fastened and equally spaced along the tubes to form a permanently tight bond

between tube and fins. Heating element capacities shall be I-B-R approved.

B. The enclosure shall be not less than 16-gauge steel which shall be supported from a 20 gauge steel continuous backplate fastened to wall. A die-formed outlet grille in the enclosure shall extend from top to partly around front.

C. Accessories according to installation requirements shall include end caps, corner pieces, wall sleeves, wall strip, column enclosures and support hangers.

Factory Applied - Prime coat for field paint
- Baked enamel (Color selected by Architect)

D. Manufacturers: Modine, Rittling, Sterling, Trane, Vulcan.

2.4 FIN-TUBE RADIATION

A. Provide fin-tube heating elements and enclosures, together with required mounting components and accessories.

B. Heating Elements shall consist of full-hard aluminum plate fins not less than .016" thick and actually embedded in copper seamless-drawn tube guaranteed for working pressure of at least 150 psi at 300 deg. F temperature.

C. Enclosures and accessories:

1. Shall be of style and dimensions indicated on plans and shall be fabricated from 16-gauge zinc-coated steel. Top of enclosures and 90 deg. corners shall consist of a heavy continuous enclosure aluminum extrusion deep-etched and hard anodized 204 R-1, with vanes sloped toward room, factory assembled to steel front skirts. Aluminum extrusion on enclosure top shall have pencil-proof air discharge slots.

2. Bottom of enclosure skirt shall have a double break for lateral stiffness, top shall be provided with deep-web gussets, and vertical stiffeners with 1/2" deep flanges shall be provided at enclosure joints.

3. Enclosures and 90 deg. corners shall have flush joints with no exposed fasteners. End enclosures and end trims shall have roll- flanged edges, allowing enclosures to telescope within, and shall have no visible fasteners.

D. Support components:

1. Shall consist of continuous mounting channel and bracket and element hangers installed every 3 to 4 feet.

2. Continuous 20-gauge roll-formed mounting channel, fabricated from zinc-coated steel, shall position extruded aluminum top 7/8" from wall.

G. Finish: All parts of the enclosure shall be primed and painted.

1. Factory applied enamel finish, color as selected by the Architect from manufacturer's standard color chart.

H. Manufacturers: Vulcan, Rittling, Slant/Fin, Sterling,

PART 3 EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which equipment is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF UNIT HEATERS

A. Install heaters in accordance with manufacturer's installation instructions.

B. Uncrate units and inspect for damage. Verify that nameplate data corresponds with unit designation.

C. Hang unit from building substrate.

D. Protect units with protective covers during balance of construction.

3.3 INSTALLATION OF CABINET HEATERS

A. Install cabinet heaters in accordance with manufacturer's installation instructions.

B. Locate cabinet heaters as shown on the drawings. Coordinate with other trades.

C. Protect units with protective covers during balance of construction.

3.4 CONVECTORS AND FIN TUBE RADIATION

A. Handle and install units in accordance with manufacturer's written instructions.

B. Support units rigidly so they remain stationary at all times. Crossbracing or other means of stiffening shall be provided as necessary. Method of support shall be such that distortion and mal-operation of units cannot occur.

C. Installed height shall be in accordance with manufacturer's recommendations.

D. Fin tube radiation: Enclosures shall be run continuously, wall-to-wall.

END OF SECTION 230725

SECTION 230760: AIR HANDLING EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the contract, including the conditions of the contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.

B. Refer to Section 230200 for HVAC General Provisions

C. Refer to Section 230210 for HVAC Basic Materials & Methods.

D. Refer to Section 230450 for Refrigeration Equipment – HVAC.

1.2 DESCRIPTION OF WORK

A. This Section includes work necessary and/or required and materials and equipment for construction of a complete system. Such work includes, but is not limited to the following:

1. Single Packaged, Gas-Fired Rooftop Air Conditioning Unit

1.3 REFERENCE STANDARDS

A. Refer to Section 230200 for a general description of requirements applying to this section.

B. AMCA Standards 210 and 300 for fans.

C. ARI Standard 410, ASHRAE Standard 33 for Heating and Cooling Coils.

D. ASHRAE Standard 52.2 and U.L. Standard 900 for media type air filters.

E. AMCA Standard 511 and 500D for Air Control Dampers.

F. AMCA Standard 611 and 610 for air flow measurement stations.

G. ARI Standard 1060 and ASHRAE Standard 84 for Air-to-Air Energy Recovery Equipment.

H. ARI Standard 260 and 430 for Air Handling Units.

1.4 QUALITY ASSURANCE

A. Refer to Section 230210 for a general description of requirements applying to this Section.

B. Whenever a variable frequency VFD drive is installed to control an AC motor, a maintenance-free, circumferential, conductive micro fiber shaft grounding ring shall be installed on the AC motor drive end to discharge shaft currents to ground. Recommended part: AEGIS SGR™ Bearing Protection Ring, as made by Electro Static Technology. Install in accordance with the manufacturer's written

instructions.

1.5 SUBMITTALS

A. Submit shop drawings in accordance with Section 230200.

B. Submit shop drawings and descriptive date for all equipment specified in this section.

1.6 SUBSTITUTIONS

A. The listed equivalent or substituted manufacturers along with the bidding related contractor shall be completely responsible to comply with all requirements on all contract documents. This shall include, but not limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades, including all required ancillary items provided by other trades. If the manufacturer or related bidding contractor does not comply with these requirements, this Contractor shall be responsible for any and all additional costs associated with the changes required by other trades.

1.7 WARRANTY/GUARANTEE

A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, General Requirements. In addition, the following special guarantee applies:

1. Each compressor unit shall be provided with manufacturer's five (5) year parts and labor warranty.

PART 2 PRODUCTS

2.1 SINGLE PACKAGED, GAS-FIRED ROOFTOP AIR CONDITIONING UNIT

A. Refrigeration System:

1. One independent refrigeration circuit with hermetic compressor, crankcase heater, strainer, high and low pressure control, compressor motor protection, and access valves.

2. A direct expansion, draw-thru evaporator coil shall be circuited so that its entire fin surface will be active during part load operation.

3. Draw-thru condenser coils with a separate sub-cooling circuit for each refrigeration system shall provide at least 15 F of sub- cooling at design conditions.

4. Outdoor air thermostats shall cycle the condenser fan motors to maintain stable operation at ambient temperature down to 35 deg. F. Condenser fan motors shall have inherent protection.

B. 100% Outdoor Air (Economizer Package):

1. Outdoor and return air dampers shall be interlocked in position by a fully modulating damper actuator. Actuator shall be spring return so that the outdoor air intake dampers will close when power to the unit is interrupted.

2. Maximum leakage rate for the outdoor air intake dampers shall not exceed 2% when fully closed and operating against a pressure differential of 0.5”WC.

3. A unit-mounted potentiometer shall be provided to adjust the outdoor and return air damper assembly to take in minimum scheduled or 10% CFM of outdoor air.

4. During economizer operation, a mixed air temperature control shall modulate the outdoor and return air damper assembly to prevent the supply air temperature from dropping below 55 deg. F.

5. Changeover from mechanical refrigeration to economizer operation shall be provided by enthalpy control.

6. The outdoor intake opening shall be covered with a birdscreen and a rain-hood that matches the exterior of the unit.

C. Exhaust Air Relief Dampers:

1. Economizer shall be equipped with barometric dampers that will open to exhaust return air as more outdoor air is supplied to the conditioned space during economizer operation. This relief shall prevent the conditioned space from over-pressurizing during economizer operation.

2. Exhaust air opening shall be covered with a birdscreen and a rain hood that matches the exterior of the unit.

D. Filters shall be 2" thick replaceable type MERV 8 per ASHRAE Standard 52.2-99 and internal metal frame work.

E. A 1,750 rpm single supply air blower motor shall have a 1.15 service factor, solid base, Class B insulation and ball bearings with permanent lubrication. All belts and pulleys shall be treated with permanent lubrication. All belts and pulleys shall be rated at least 25% above the nominal drive horsepower. The fan shaft ball bearings shall have minimum average bearing life (AFBMA L-10) in excess of 100,000 hours at the maximum class RPM.

F. Roof Curb:

1. Roof curb shall be supplied by the unit manufacturer to provide a watertight seal between the roof and the unit.

2. Roof curb shall be approved by the National Roofing Contractor's Association.

3. Roof curb shall be full perimeter with all utility and duct connections within the perimeter of the curb eliminating the need for other roof penetrations.

G. Unit Construction:

1. All sheet metal parts shall be constructed of a zinc coated, commercial grade galvanized steel. All external surfaces shall be finished with a UL approved coating system.

2. Removable side panel shall provide easy access for maintenance, service and adjustment.

3. Unit shall be single wall construction with foil faced insulation such that insulation is not exposed to the air stream.

4. Unit shall have lifting lugs on each of the four upper corners.

5. Condenser coils and fan discharge shall be protected by heavy duty wire guards.

H. Basic Safety/Operating Controls - Unit manufacturer shall supply the following safety/operating control features:

1. A firestat to deenergize the unit if the temperature of the air returning to the unit rises to 145 deg. F.

2. A thermostat to deenergize the compressors when the suction line temperature drops below 22 deg. F.

3. A five minute timer to prevent the compressor from short cycling.

4. A lock out circuit to prevent the compressors from cycling on one of their safety controls.

5. A cutout to protect the compressors during abnormally low voltage conditions.

I. Unit shall be completely factory wired, piped, charged and tested by the manufacturer before shipment.

J. Gas Heating Section:

1. Manufacturer shall furnish a natural gas furnace constructed of 20 gauge aluminized steel tubes.

2. Furnace shall include the following controls and safety devices:

a. Intermittent spark ignition with two stage gas valve with pressure regulator.

b. Centrifugal blower to maintain positive flue pressure with air pressure safety switch.

c. Electronic ignition with flame sensor and lockout safety valve.

d. High temperature limit thermostat with automatic reset.

L. Manufacturer: Trane, York/Johnson Controls, Carrier, Lennox

M. Manufacturer shall furnish start-up.

1. Any listed equivalent manufacturer and the Mechanical Contractor shall be completely responsible to comply with all requirements on the contract documents. This shall include, but not be limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades.

O. Any listed equivalent manufacturer and the Mechanical Contractor shall be completely responsible to comply with all requirements as indicated on the contract documents. This shall include, but not be limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which equipment is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to installer.

B. Install in accordance with manufacturer's recommendations. Unit and all component sections shall be properly supported and vibration isolated.

3.2 INSTALLATION

A. Verify that coils, filters, motors, drives and other components are matched with the proper unit.

B. Assemble unit components following manufacturer's instructions for handling, testing and operation. Repair damaged galvanized areas, and paint in accordance with manufacturer's written recommendations.

C. Vacuum clean interior of units prior to operation.

D. Repair air leaks from or into casing that can be heard or felt during normal operation.

E. Install rooftop units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

F. Support: Install and secure roof curb to roof structure, in accordance with National Roofing Contractor's Association (NRCA) installation recommendations and shop drawings. Install and secure rooftop units on curbs and coordinate roof penetrations and flashing.

G. Perform field mechanical balancing in accordance with Section 230950: TESTING AND BALANCING OF MECHANICAL SYSTEMS.

3.3 AUTOMATIC TEMPERATURE CONTROLS

A. Coordination of control work with the BAS shall include, but not be limited to, the following items as described in Section 230900: ATC.

B. Variable Volume Rooftop Units:

1. The following items shall be provided by the equipment manufacturer:

a. Motor starters and overload protection.

b. Control transformers.
d. Dampers and damper motors.
e. Terminal blocks for all wiring connections between equipment and control devices.
f. Analog air filter differential pressure sensor.
h. Manual reset freeze stat.

2. The following items shall be furnished by the BAS Contractor and installed by the equipment manufacturer:

   a. DDC Controller.
   b. Discharge air temperature sensor.
   c. Discharge humidity sensor.
   d. Return air temperature sensor.
   e. Return air humidity sensor.
   f. Temperature sensor at exhaust air outlet.
   g. Mixed air average temperature sensor.
   h. Variable frequency drives with status/alarm feedback signal for monitoring via the BAS.

3. The following items shall be field mounted and wired by the BAS Contractor:

   a. Discharge air temperature sensor.
   b. Discharge humidity sensor.
   c. Heating coil discharge air temperature sensor.
   d. Manual reset freezestat (supplied by ATC).

E. The unit DDC controllers shall be networked to a standard protocol translator or gateway so system points shall be available for communications and control from the Building Automation System (BAS)/Automatic Temperature Controls (ATC) System. The protocols available from the protocol translator to the BAS/ATC System shall be BACNET (MSTP), LON or N2.

System points shall be configured to the BAS/ATC System by the BAS/ATC System Contractor. The mapping of points to the BAS/ATC front-end/PC shall be done by the BAS/ATC Contractor. Any software or hardware necessary including labor to accomplish this work shall be provided by the BAS/ATC System Contractor.

END OF SECTION 230760

SECTION 230900: AUTOMATIC TEMPERATURE CONTROL

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Section 230200 and drawings are hereby made a part of this section as fully as if repeated herein.

B. The Mechanical Contractor shall coordinate with the work of Division 26 and the Fire Alarm System vendor for locations and mounting of all duct smoke detectors. These devices are shown on the Mechanical Drawings for reference only to show the intent of the work. All locations shall be determined based on approved shop drawings from the Fire Alarm System vendor and the Contractor for the work of Division 26, Electrical.

1.2 DESCRIPTION OF WORK

A. Provide labor, material and supervision necessary to install a complete direct digital control system of temperature controls to control all HVAC Systems, associated components and accessories as described herein. System shall be an extension of the existing Johnson Controls Metasis currently installed at the campus.

1.3 SUBMITTALS

A. Submit shop drawings and manufacturer's data sheets of all equipment.

B. Submit manufacturer's certificates of conformance with applicable codes.

C. Furnish point-to-point diagram of automatic temperature control system approval, including heating, ventilating and air conditioning equipment wiring diagrams where temperature control connections are required.

D. Provide ten (10) copies of submittal data within thirty (30) days of contract award.

E. Submittal shall consist of:

1. System Architecture showing all digital and pneumatically actuated devices.

2. Equipment lists of all proposed devices and equipment including data sheets of all products.

3. Valve, damper and well and tap schedules showing size, configuration, capacity and location of all equipment.

4. Data entry forms for initial parameters. Contractor shall provide English listing of all analog points with columnar blanks for high and low warning limits and high and low alarm limits, and a listing of all fan systems with columnar blanks for beginning and end of occupancy periods; and samples of proposed text for points and messages (for at least two systems of at least 15 points total) including sample 480 character alarm message. All text shall be approved prior to data entry.

5. Wiring and piping interconnection diagrams including panel and device power and sources.

6. Sketches of all graphics.

1.4 QUALITY ASSURANCE

A. Insure that all work and equipment is installed in accordance with manufacturer's warranty requirements.

B. Provide adequate supervision of labor force to assure that all aspects of specifications are being fulfilled.

C. The system shall be engineered, programmed and installed by personnel trained and regularly employed by the control's manufacturer.

D. Supplier shall have technical support to promptly respond within 24 hours or less to service calls to the site with technical staff, spare parts inventory and test and diagnostic equipment.

E. Codes and Approvals:

1. The complete system installation shall be in strict accordance with national and local electrical codes. All devices designed for or used in line voltage applications shall be UL listed.

a. All microprocessor based devices shall be UL916 listed.

b. All electrical environmental control and monitoring devices shall be UL429 and/or UL873 listed.

2. All electronic equipment shall conform to the requirements of FCC regulation Class B, Part 15, Section 15 governing radio frequency electromagnetic interference and be so labeled.

3. The complete system shall conform to ANSI/ASHRAE Standard 135.95, BACNET.

F. All system components shall be designed and built to be fault tolerant.

1. Provide satisfactory operation without damage at 100% above and 85% below rated voltage and at +3 Hertz variation in line frequency.

2. Provide static, transient, and short circuit protection on all inputs and outputs. Communication lines shall be protected against incorrect wiring, static transients and induced magnetic interference. Bus connected devices shall be A.C. coupled or equivalent so that any single device failure will not disrupt or halt bus communication.

1.5 ELECTRICAL WIRING

A. All electrical wiring, components and accessories in connection with the Automatic Temperature Control System shall be furnished and installed by the control manufacturer.

1. Electrical Contractor shall provide all wiring to duct smoke detectors.

2. Unless stated otherwise in the design documents, the ATC Contractor is responsible for providing control power to all valves, actuators, devices and components within the DDC System regardless of the selected voltage of those devices. This also includes all 120 volt power circuits required for devices, panels and control equipment.

3. The ATC Contractor shall be responsible for providing the control interface between terminal unit condensate pumps and their respective units at the required voltage of these devices in order to shut down the terminal unit in the event of high water level in the condensate pump receiver.

B. Control wiring shall include all wiring necessary to interface with new controls, such as relays and transducers, and shall also include electric and electronic devices such as freezestats, electronic sensors, relays, flow switches and controlled devices such as valve and damper operators, both electric/electronic actuated devices. Pilot devices such as ON/OFF switches and thermostats installed in series with line voltage circuits shall be considered to be control wiring.

1.6 AUTOMATIC TEMPERATURE CONTROL

A. Provide a DDC System of automatic temperature control which shall be as manufactured by Johnson Controls, Inc., as installed by Modern Controls, Inc. The system shall be complete in all respects including labor, materials, equipment and services necessary.

B. All electrical wiring in connection with the installation of the automatic temperature control system shall be furnished and installed under the direct supervision of the control manufacturer.

PART 2 PRODUCTS

2.1 BMCS COMPUTER HARDWARE

2.2 SENSORS

A. Solid state room sensors shall be of the wire wound resistance type element. Sensor shall be equipped with visual readout and adjustment. Sensors shall be of the completely solid state type with no moving contacts. Printed circuit board under thermostat cover shall contain a low mass resistance type setpoint dial and amplifier. Provide test points for measuring output voltage. Sensors shall be direct or reverse acting as required for the sequence of operation.

B. Thermostat shall provide the application for night setback override.

C. Thermostats shall be mounted at ADA height (48” above floor).

2.3 SMOKE DETECTORS

A. Duct type ionization smoke detectors shall be furnished by the Mechanical Contractor and installed by the Mechanical Contractor in the supply and return air stream. The Electrical Contractor shall provide wiring from each detector to the Fire Alarm System panel.

B. The Electrical Contractor shall provide an alarm output signal from the FAS panel to the BAS for unit shutdown.

2.4 ACTUATORS

A. Electronic actuators shall be sized to operate their appropriate dampers and valves with sufficient reserve power to provide smooth modulating action or two-position action as specified.

B. Provide integral, auxiliary switches for direct coupled actuators to indicate when a desired position is reached or to interface additional controls for a specific sequence.

2.5 SENSOR TRANSMITTERS

A. Duct and immersion sensors shall have minimum spans as required to meet the temperature requirements. Duct sensors shall have sensing elements of sufficient length and accuracy to measure average duct temperature in each location.

B. Sensors shall be of corrosion resistant construction, tamperproof, suitable for mounting on a vibrating surface. Exposed capillaries shall be temperature compensated, and armored or installed in protective tubing.

C. All sensing elements for water pipe mounting shall be of the rod and tube type with linear output and shall be furnished complete with separable protecting wells filled with heat conductive compound. Sensors shall be factory calibrated and tamperproof. If easily adjustable sensors are provided, they shall be located inside metal enclosures with cylinder lock and key to prevent unauthorized setting.

D. Safety Devices: Provide the following:

1. Low limit, electric type, with 20’ long serpentine element, with manual reset, set for 37°F for “freeze” protection and 55°F for fan discharge application, unless otherwise noted.

2. Air and water duty flow switches: Differential pressure type for fan and pump status.

3. Carbon monoxide sensor/transducer/meter shall be analog type, requiring no field or periodic calibration, suitable for wall mounting.

   a. Microprocessor controlled digital display of 0 to 250 ppm CO.
   b. Analog output of 4 to 20 milliamps.
   c. UL listed housing, suitable for an operating environment of 0 to 125 F/ 10 to 90% RH.
   d. Repeatability of +/- 10% at 50 ppm; linearity of +/- 10%.
   e. Power input of 3.5 watts at 24 VAC.
   f. Make: Macurco inc. model CM-2B.
   g. Manufacturers: Air Test Technologies, Inc., Macurco, Vaisala, Inc.

4. Carbon dioxide sensor/transducer suitable for wall or duct mounting.

   a. Analog output of 4 to 20 milliamps corresponding to 0 to 2000 ppm CO_2.

b. ABS plastic housing, suitable for an operating environment of 0 to 125 F/ 0 to 100% RH, non-condensing.
c. Repeatability less than +/- 20 ppm.
d. Response time less than 60 seconds.
e. Power supply, 24 VAC.
f. Make: Vaisala Inc. model GMW 21 (wall)
GMD 20 (duct)
g. Manufacturers: Air Test Technologies, Inc., Macurco, Vaisala, Inc.

a. Mechanical float devices attached to or inserted within the auxiliary pan are not acceptable.

b. Sensor shall be activated when there is at least ¼ inch of water, but no more than ½ inch of water in the auxiliary pan.

c. Equal to Kele Model WD-1B water detector.

(1) Weatherproof cast aluminum enclosure with adjustable mounting feet.
(2) 11-27VAC/VDC, 60 Hz, SPDT alarm contacts.
(3) LED indicators for power (green) and alarm (red).
(4) Fully adjustable detection level.

2.6 CONTROL VALVES

A. Valves shall be rated for a minimum of 150 percent (150%) of system operating pressure at the valve location but not less than 125 psig.

B. 2" and Smaller: Valves shall be bronze body with screwed or flared connections.

C. 2-1/2" and Larger: Valves shall be bronze or iron body, flanged.

E. Flow characteristics:

1. Three-way valves shall have a linear relation of flow vs. valve position.

2. Two-way valve position vs. flow relation shall be equal percentage for water flow control.

F. Maximum pressure drop through valve:

1. Modulating water flow control: 1/2 the pressure drop through the apparatus with maximum of 10 feet of water. Two position water valves shall be line size.

2. Modulating steam control: 67 percent (67%) of inlet gauge pressure but not to exceed 45 percent (45%) of inlet absolute pressure (acoustic velocity limitation).

2.7 CONTROL DAMPERS

A. The ATC Sub-contractor shall furnish all the controlled dampers of the type and sizes indicated on the drawings for installation by the sheet metal Sub-contractor.

B. All 2-position control dampers shall be parallel blade and sized for minimum pressure drop, at the specified duct size.

C. All modulating dampers shall be opposed blade and sized for an effective linear air flow control characteristics within the angle of rotation and maximum pressure drops specified. Information shall be provided to the sheet metal Subcontractor for determining the proper duct reductions or baffles used.

D. Damper frames shall not be less than 16 gauge galvanized steel, formed with corner braces for extra strength, with mounting holes for enclosed duct mounting.

E. All damper blades shall be of not less than 16-gauge galvanized steel formed for strength and high velocity performance. Blades on all dampers must not be over 8" in width. Blades shall be secured to 1/2" diameter zinc plated axles by zinc plated bolts and nuts. All blade bearings shall be nylon or oilite. Blade side edges shall be sealed off against spring stainless steel seals. Teflon coated thrust bearings shall be provided at each end of every blade to minimize torque requirements and insure smooth operation. All blade leakage hardware shall be constructed of corrosion resistant, zinc plated steel and brass.

F. Dampers shall be suitable for operation between -40 and 200 degrees. The control manufacturer shall submit leakage and flow characteristics plus a size schedule for all controlled dampers.

G. All blade edges shall have inflatable seal edging that shall be rated for leakage less than 10 cubic feet per minute per square foot of damper area at a differential pressure of 4" of water when the damper is being held by a torque not to exceed 50 inert lbs. Leakage shall not exceed 1/2 of 1% of total flow.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install system and materials in accordance with manufacturer's instructions and roughing-in drawings, and details and drawings. Install electrical work and use electrical products complying with requirements of these specifications. Mount controllers at convenient locations and heights.

B. All wiring shall be properly supported and run in a neat and workmanlike manner. All wiring exposed and in equipment rooms shall run parallel to or at right angles to the building structure. All piping and wiring within enclosures shall be neatly bundled and anchored to prevent obstruction to devices and terminals. All wiring shall be in accordance with all local and national codes. Low voltage wiring for space temperature sensors, communication bus between terminal units, etc., above accessible ceilings in finished spaces on the floors may be plenum rated cable. Wiring in all other locations shall be installed in EMT conduit. All electronic wiring shall be #18 AWG minimum THHN and shielded if required, except standard network (Ethernet, LonWorks, etc.) cabling shall be as tested and recommended in lieu of #18 gauge twisted, #22 or #24 gauge is acceptable if used as a part of an engineered structured cabling system. The control manufacturer must submit technical and

application documentation demonstrating that this cabling system has been tested and approved for use by the manufacturer of both the control system and the engineered structured cabling system.

C. Provide all sensing, control, and interlock wiring for the following:

System inputs and outputs
System communications
System power
System interlocks
Unit controls

D. The Control Manufacturer shall enter all computer data into the Host computer including all graphics, control programs, initial approved parameters and settings, and English descriptors. The Control Manufacturer shall maintain diskette copies of all data file and application software for reload use in the event of a system crash or memory failure. One copy shall be delivered to the owner during training sessions, and one copy shall be archived in the Control Manufacturer's local software vault.

3.2 DATA CONTROL (D/C) AND GRAPHICS SUMMARY

A. All hardware, custom software, application software, graphics, etc., necessary to accomplish the control sequences and display the graphics specified shall be provided as part of this contract. Provide all controllers, inputs, outputs, valves, dampers, actuators
and flow meters required to provide the control and graphic data described. Provide software setpoints required for display in logical groups and graphics.

B. Each digital output shall have a software-associated monitored input. Any time the monitored input does not track it's associated command output within a programmable time interval, a "command failed" alarm shall be reported.

C. Where calculated points (such as CFM) are shown, they shall appear in their respective logical groups.

D. Unless otherwise specified or approved prior to bidding, the primary analog input and the analog output of each DDC loop shall be resident in a single remote panel containing the DDC algorithm, and shall function independent of any primary or UC communication links. Secondary (reset type) analog inputs may be received from the primary network, but approved default values and/or procedures shall be substituted in the DDC algorithm for this secondary input if network communications fail or if the secondary input becomes erroneous or invalid.

3.3 ACCEPTANCE

A. The Control Manufacturer shall completely check out, calibrate and test all connected hardware and software to insure that the system performs in accordance with the approved specifications and sequences of operations approved.

B. Witnessed acceptance demonstration shall display and demonstrate each type of data entry to show site specific customizing capability; demonstrate parameter changes; execute digital and analog commands; and demonstrate DDC loop stability via trend of inputs and outputs.

3.4 MANUALS

A. The following manuals will be provided:

1. An Operators Manual shall be provided with graphic explanations of keyboard use for all operator functions specified under Operator Training.

B. A manual shall be provided including revised as-built documents of all materials required under the paragraph "SUBMITTALS" on this specification.

C. Two Operators Manuals, and two As-Built Manuals shall be provided to the owner.

3.5 TRAINING

A. All training shall be by the BMCS contractor and shall utilize operators manuals and as-built documentation.

B. Operator training shall include three (3) four-hour sessions encompassing modifying text and graphics, sequence of operation review, selection of all displays and reports, use of all specified OWS functions, troubleshooting of sensors (determining bad sensors), and password assignment and modification. One training session shall be conducted at system completion, one shall be conducted forty five days after system completion, and one at ninety (90) days, or as requested by the Owner..

3.6 SERVICE GUARANTEE

A. The control system herein specified shall be free from defects in workmanship and material under normal use and service. After completion of the installation, the control manufacturer shall regulate and adjust all thermostats, control valves, motors and other equipment provided under this contract. If within twelve (12) months from date of acceptance either for beneficial use of final acceptance, whichever is earlier, any of the equipment herein described is proven to be defective in workmanship or materials, it will be replaced or repaired free of charge. The control manufacturer shall, after acceptance, provide any service incidental to the proper performance of the control system under guarantee outlined above for the period of one year. Normal maintenance of the system or adjustments of components is not to be considered part of the guarantee. The control manufacturer will upon completion of the installation, during the warranty period, make available to the Owner, an annual service agreement covering all labor and material required to efficiently maintain the control system.

3.7 FINAL ADJUSTMENT

A. After completion of installation, adjust thermostats, control valves, motors and similar equipment provided as work of this section.

B. Final adjustment shall be performed by specially trained personnel in direct employ of installer of primary temperature control system.

END OF SECTION 230900

SECTION 230950: TESTING & BALANCING OF MECHANICAL SYSTEMS

PART 1 GENERAL

1.1 JOB CONDITIONS

A. Systems shall be completely installed and in continuous operation as required to accomplish the tests.

B. Heating, ventilating and air conditioning equipment shall be completely installed and in continuous operation as required to accomplish the balance work specified.

C. Adjust and balance shall be performed when outside conditions approximate design conditions indicated for heating and cooling functions.

D. Make at least two inspections of the mechanical systems during construction to verify that balancing procedures may be accomplished. Report findings to the Architect/Engineer.

E. Balancing firm shall balance Mechanical System two (2) times. The first time shall be considered a rough balance. Any discrepancy in air flow shall be addressed to the Architect/Engineer. The final balancing will be accomplished after review of rough balance reports.

F. The final balancing reports shall be submitted and approved prior to project's being considered complete; i.e., commencement of warranties.

1.2 ENGINEER QUALIFICATIONS

A. The firm shall be an independent organization having no affiliation with construction contractors, equipment sales or design engineering.

B. The firm shall specialize in balancing heating, ventilating and air conditioning systems.

C. The firm shall show proof of having balanced and tested at least five projects of similar size and scope.

D. All field work shall be under the direct supervision of a registered Professional Engineer who is a full-time employee of the balancing firm.

E. The firm shall be certified by and a member of the AABC (Associated Air Balance Council) or NEBB (National Environmental Balancing Bureau).

1.3 REPORT

A. Data Sheets:

1. Submit data sheets on each item of testing equipment required.

2. Include name of device, manufacturer's name, model number, latest date of calibration and correction factors.

B. Report Forms:

1. Submit specimen copies of report forms.

2. Forms shall be 8-1/2 x 11 inch paper for loose-leaf binding, with blanks for listing of the required test ratings and for certification of report.

3. Reports shall be on standard forms published by AABC or NEBB.

PART 2 PRODUCTS

2.1 AIR BALANCE INSTRUMENTS

A. Alnor Velometer with probes and alnor pitot tube.

B. Rotating Vane Anemometer: 4 inch size.

C. ASHRAE Standard Pitot Tubes, stainless steel 5/16 inch outside diameter, lengths 18 inches and 36 inches.

D. Magnehelic Differential Air Pressure Gauges, 0 to 0.5 inches, 0 to 1.0 inch and 0 to 5.0 inches water pressure ranges, each arranged as a portable unit for use with a standard Pitot tube.

E. Combination Inclined-Vertical Portable Manometer, range 0 to 5.0 inches water.

2.2 WATER BALANCING INSTRUMENTS

A. 30 Inch Mercury U-Tube Manometer, 200 psig, with 3 valve bypass assembly and return wells or mercury check valves.

B. Inspector's gauge testing set.

C. Water Differential Pressure Gauge, 4-1/2 inch dial, 0 to 100 psi range.

D. Pressure gauge measurement points, quick connect couplings, 1/4 inch psi.

2.3 SYSTEM PERFORMANCE MEASURING INSTRUMENTS

A. Insertion Thermometers, with graduation at 0.5 degrees F for air and 0.1 degrees F for water.

B. Sling Psychrometer.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

A. Arrange and pay for all tests.

B. Notify Architect/Engineer at least three working days in advance of test and conduct in presence of Architect/Engineer

C. Tests to be performed prior to insulation, covering or concealment.

D. Provide signed report of completion of test with signature of witnesses. Report shall indicate:

1. System Tested

2. Date

3. Specified test requirements and actual testing results

E. The balancing firm shall report to and review the work required with the Architect/Engineer before beginning field balance work. The balancing firm shall make at least two inspections of the air systems during construction and shall report his findings in writing to the Architect/Engineer.

F. The balancing firm shall cooperate with the Architect/Engineer and the Mechanical Contractor to effect smooth coordination of the balancing work with the job schedule.

G. The balancing firm shall be responsible for getting the various systems into proper operation. They shall enlist the aid of the equipment suppliers and Mechanical Contractor as may be required to effect proper operation consistent with the contract plans and specifications.

H. When the balancing firm cannot balance a belt-driven piece of equipment with the supplied belts and sheaves, inform the Mechanical Contractor that the Mechanical Contractor shall provide additional sheaves as spelled out in other Division 23 Sections.

3.2 CIRCULATING WATER SYSTEM TEST

A. All piping tests shall be applied not only to piping, but also to all devices and equipment connected thereto with the exception of control valves, boilers or any other equipment which may be damaged by the test pressure. All valves shall be full open.

B. Test at 100 psi hydrostatic pressure for 6 hours:

1. Record pressures each hour

2. Repair all leaks

3. Retest until 6 hours can be completed with no leaks or loss of pressure.

C. After completion of successful test, strainers shall be cleaned, then system shall be backflushed and strainers cleaned again.

3.3 DUCTWORK TESTING

A. Witness testing conducted by the Mechanical Contractor per Section 15600, PART 3: EXECUTION.

3.4 BALANCING PROCEDURE

A. Air System Balance:

1. With the fan supply system set to handle normal minimum outdoor air, the balancing firm shall perform the following tests and compile the following information:

Air Handling Equipment

a. Design Conditions:

(1) CFM Supply Air
(2) Static Pressure
(3) CFM Fresh Air
(4) Fan RPM

b. Installed Equipment:

(1) Manufacturer
(2) Size/Model Number
(3) Motor HP, Voltage, Phase, Full Load Amperes

c. Field Test:

(1) Fan Speed
(2) No Load Operating Amperes
(3) Fan Motor Operating Amperes
(4) Calculated BHP

d. Test for Total Air:

(1) Size of discharge, return air and outside air ducts.
(2) Number and locations of Velocity Readings taken.
(3) Duct Average Velocity

(4) Total CFM
(5) Outside Air CFM
(6) Return Air CFM

e. Individual Outlets (Diffusers, Registers and/or Grilles):

(1) Identify each outlet or inlet as to location and area and fan system
(2) Outlet, manufacture and type
(3) Outlet size
(4) Outlet free area, core area, or neck area
(5) Required FPM and test velocity found for each outlet.

(6) Required CFM and test results for each outlet

2. After completion of tests, adjustment and balancing under minimum fresh air conditions, set the system for 100% fresh air. Repeat the total CFM tests to check field versus design conditions. The results under 100% fresh air cycle shall agree with conditions found under "minimum fresh air operation" before the system is considered to be in balance. Adjustments of the proper dampers shall be made to achieve balance.

3. Testing and adjusting of individual outlets shall be performed under procedures recommended by the manufacturers of the outlets. All outlets shall be set for air pattern required and all main supply air and return air dampers to be adjusted and set for design CFM indicated. Any required changes in air patterns, settings, etc., necessary for achieving correct air balance, shall be provided by this Contractor. Total CFM of all outlets shall agree with total CFM of all branches and the grand total shall agree with the air volume for the fan(s).

B. Water Balance:

1. Water balance shall include heating water, chilled water and condenser water systems. The balancing agency shall perform the following tests, compile data and submit reports.

2. Pumps:

a. Design Data

(1) GPM, head
(2) RPM, BHP

b. Installed Equipment

(1) Manufacturer, Size
(2) Type Drive
(3) Motor HP, Volts, Cycles and Phase

(4) Full Load Amperes

c. Field Test

(1) Discharge Pressures: Full flow & no flow
(2) Suction Pressures: Full flow & no flow
(3) Operating Head and GPM
(4) No Load Amperes (where possible)
(5) Full Flow Amperes, No Flow Amperes
(6) Calculated BHP

3. Heating Elements Including Loop Water to all terminal Units:

a. Design Data:

(1) MBH Specified, GPM Specified
(2) Entering Water Temperature (EWT)
(3) Entering Air Temperature (EAT)
(4) Water Temperature Drop (DTW)
(5) Element Type Specified

b. Field Test:

(1) Identify each element as to location
(2) Required water temperature drop corrected for item (3) above
(3) Actual entering air and water conditions (temperature and GPM)
(4) Adjust element until required temperature drop is obtained

D. In addition to the above work, the Balancing Firm shall check the operation of all automatic temperature control equipment; verify all thermostat, aquastat, etc., set-points and operations; and enlist the aid of the Mechanical Contractor and the Control Subcontractor to make necessary adjustments where required.

END OF SECTION 230950

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

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 ALTERNATES

A. Refer to Division 1 Section, "Alternates" for description of work under this Section affected by Alternates.

1.3 SUMMARY

A. Section Includes:

1. Electrical equipment coordination and installation.
2. Sleeves for raceways and cables.
3. Sleeve seals.
4. Foam Duct Sealant.
5. Grout.
6. Plywood Backboards.
7. Common electrical installation requirements.

B. Provide all labor, materials, equipment, and services necessary for and incidental to the complete installation and operation of all electrical work.

C. Unless otherwise specified, all submissions shall be made to, and acceptances and approvals made by the Architect and the Engineer.

D. Contract Drawings are generally diagrammatic and all offsets, fittings, transitions and accessories are not necessarily shown. Furnish and install all such items as may be required to fit the work to the conditions encountered. Arrange conduits, equipment, and other work generally as shown on the Contract Drawings, providing proper clearance and access. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawings for approval in accordance with Article "Submittals" specified below. The right is reserved to make reasonable changes in location of equipment, boxes, and conduit, up to the time of rough-in or fabrication.

E. Conform to the requirements of all rules, regulations and codes of local, state and federal authorities having jurisdiction.

F. Coordinate the work under Division 26 with the work of all other construction trades.

G. Be responsible for all construction means, methods, techniques, procedures, and phasing sequences used in the work. Furnish all tools, equipment and materials necessary to properly perform the work in first class, substantial, and workmanlike manner, in accordance with the full intent and meaning of the Contract Documents.

H. Arrange conduit, wiring, equipment, and other work generally as shown, providing proper clearances and access. Carefully examine all Contract Drawings and fit the work in each location without substantial alteration. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawings for approval in accordance with *Submittals* as hereinafter specified. The right is reserved to make reasonable changes in location of equipment, conduit and wiring up to the time of rough-in or fabrication.

I. Perform the work in a first-class, substantial and workmanlike manner. Any materials installed which do not present an orderly and neat workmanlike appearance shall be removed and replaced when so directed by the Engineer, at the Contractor's expense.

J. Contact and coordinate service entrance equipment and layout with local power company prior to ordering or installing any service entrance equipment. Contractor shall furnish and install all incoming raceway and service entrance cables. If the power company plans to install cable and/or conduit, Contractor is responsible for proper coordination of cable, conduit, lug sizes, etc., for proper interface between utility owned/installed equipment and Contractor-installed equipment.

K. Coordinate incoming telephone raceway with local telephone utility company. Contractor shall provide required conduit size as determined by the telephone company. Contractor is responsible for contacting and coordination with the telephone company prior to ordering or installing any telephone entrance equipment.

L. The Owner shall make the application for electrical service and pay for all service charges, as coordinated with the Contractor.

M. Coordinate incoming cable television raceway with the local cable television company.

1.4 PERMITS AND FEES

A. Obtain all permits and pay taxes, fees and other costs in connection with the work. File necessary plans, prepare documents, give proper notices and obtain necessary approvals. Deliver inspection and approval certificates to Owner prior to final acceptance of the work.

B. Permits and fees shall comply with Division 1 Section, *General Requirements.*

C. Notify Inspection Authorities to schedule inspections of work.

D. Notify Architect and Engineer in advance of scheduled inspections.

E. An electrical foreman, superintendent or other supervisor shall be in attendance for all scheduled inspections

1.5 EXAMINATION OF SITE

A. Examine the site, determine all conditions and circumstances under which the work must be done, and make all necessary allowances for same. No additional cost to the Owner will be permitted for Contractor's failure to do so.

B. Examine and verify specific conditions described in individual specifications sections.

C. Verify that utility services are available, of the correct characteristics, and in the correct locations.

1.6 INTERPRETATION OF DOCUMENTS

A. Any discrepancies between Drawings, Specifications, Drawings and Specifications, or within Drawings and Specifications shall be promptly brought to the attention of the Owner during the bidding period. No allowance shall subsequently be made by reason of failure to have brought said discrepancies to the attention of the Owner during the bidding period or of any error on the Bidder's part.

B. The locations of products shown on Drawings are approximate. Place the devices to eliminate all interference with above-ceiling ducts, piping, etc. Where any doubt exists, the exact location shall be determined by the Owner.

C. All general trades and existing conditions shall be checked before installing any outlets, power wiring, etc.

D. Equipment sizes shown on the Drawings are estimated. Before installing any wire or conduit, obtain the exact equipment requirements and install wire, conduit, or other item of the correct size for the equipment actually installed. However, wire and conduit sizes shown on the Drawings shall be taken as a minimum and shall not be reduced without written approval from the Owner.

E. Where variances occur between the Drawings and Specifications or within either document itself, the item or arrangement of better quality, greater quality, or higher cost shall be included in the Contract Price. The Engineer will decide on the item and manner in which the work shall be installed.

F. Contract Drawings are generally diagrammatic and all offsets, fittings, transitions, and accessories are not necessarily shown. Furnish and install all such items as may be required to fit the work to the conditions encountered. Arrange conduits, equipment, and other work generally as shown on the Contract Drawings, providing proper clearance and access. Where departures are proposed because of field conditions or other causes, prepare and submit detailed Shop Drawings for approval in accordance with Article "Submittals" as herein after specified. The right is reserved to make reasonable changes in location of equipment, piping, and ductwork, up to the time of rough-in or fabrication.

G. Work not specifically outlined, but reasonably incidental to the completion of the work, shall be included without additional compensation from the Architect, Engineer and Owner.

H. The complete set of Architectural, Civil, Structural, Mechanical, and Electrical Drawings and Specifications apply to this work. The successful Bidder shall familiarize himself with all other related documents.

1.7 MATERIALS AND EQUIPMENT

A. Materials and equipment installed as a permanent part of the project shall be new, unless otherwise indicated or specified, and of the specified type and quality. Existing items of equipment are being relocated under another Division of these specifications. The Contractor shall be responsible for connecting all utilities as shown on the drawings, to equipment identified as existing.

B. Where material or equipment is identified by proprietary name, model number and/or manufacturer, furnish named item, or its equal, subject to approval by Engineer. Substituted items shall be equal or better in quality and performance and must be suitable for available space, required arrangement, and application. Submit all data necessary to determine suitability of substituted items, for approval.

C. The suitability of named item only has been verified. Where more than one item is named, only the first named item has been verified as suitable. Substituted items, including items other than first named shall be equal or better in quality and performance to that of specified items, and must be suitable for available space, required arrangement and application. Contractor, by providing other than the first named manufacturer, assumes responsibility for all necessary adjustments and modifications necessary for a satisfactory installation. Adjustments and modifications shall include but not be limited to electrical, structural, support, and architectural work.

D. Substitution will not be permitted for specified items of material or equipment where noted.

E. All items of equipment furnished shall have a service record of at least five (5) years.

1.8 ELECTRICAL WORK UNDER OTHER DIVISIONS

A. Mechanical Equipment and Systems

1. In general, power wiring and motor starting equipment for mechanical equipment and systems are furnished and installed under Electrical Division 26.

2. Certain mechanical units are furnished from the factory with starters, contactors, transformers, fuses, wiring, etc., required for fans, pumps, etc. When this equipment is supplied from the factory, the Electrical Contractor must supply power circuit(s) to the unit and a disconnecting means. Coordinate with Mechanical Contractor so that one, and only one, set of starters, fuses, switches, etc., is provided and installed.

3. In general, control and interlock equipment for FIVAC systems (including associated wiring, conduit, transformers, relays, contacts, etc.) is furnished under Division 23. Division 26 shall install and connect all such equipment as necessary.

4. Controls, wiring, conduit, transformers, etc., for smoke, fire, and motor-operated dampers are provided under Division 23. Division 26 shall install and connect all such equipment.

B. Architectural Equipment: In general, any electrically operated or controlled equipment furnished under architectural divisions shall be supplied with control wiring, transformers, contacts, etc. Provide power circuits and disconnects to such equipment and install all electrical control equipment related thereto.

C. Kitchen Equipment: In general, any electrically operated or controlled equipment furnished under the kitchen equipment shall be supplied and installed by the kitchen equipment supplier. Provide wiring devices, power circuits and disconnects for such equipment and install all electrical control equipment related thereto. Refer to Kitchen Consultant's drawings for additional electrical wiring and conduits.

D. Owner Furnished Equipment: In general, Owner furnished equipment is either provided or wired by the equipment supplier. Provide power circuits to such equipment and make final connections to equipment being provided by the Owner.

E . Carefully review the Contract Documents and coordinate the electrical work under the various Divisions.

1.09 FIRE SAFE MATERIALS

A. Unless otherwise indicated, materials and equipment shall conform to UL, NFPA and ASTM standards for fire safety with smoke and fire hazard rating not exceeding flame spread of 25 and smoke developed of 50.

1.10 REFERENCED STANDARDS, CODES AND SPECIFICATIONS

A. Specifications, Codes and Standards listed below are included as part of this Specification, latest edition:

1.	AIA	-	Guidelines for Construction and Design of Hospitals and Health Care Facilities
2.	ADA		Americans with Disabilities Act
3.	ANSI		American National Standards Institute
4.	ASME		American Society of Mechanical Engineers
5.	ASTM		American Society for Testing and Materials
6.	CSA	-	Canadian Standards Association
7.	EPA	-	Environmental Protection Agency
8.	FM		Factory Mutual
9.	IBC	-	International Building Code
10.	IEEE		Institute of Electrical and Electronics Engineers
11.	MDE		Maryland Department of the Environment

12.	NEC	National Electrical Code
13.	NEC	National Electrical Code – Article 517
14.	NECA	National Electrical Contractors Association
15.	NEMA	National Electrical Manufacturers Association
16.	NFPA	National Fire Protection Association
17.	[NFPA-99	National Fire Protection Association - Health Care Facilities]
18.	OSHA	Occupational Safety and Health Act
19.	UL	Underwriters' Laboratories

20. The application standards of the local electric utility company.

B. Electrical construction materials shall, where a listing is normal for the particular class of material, be listed in *Electrical Construction Materials List* of the Underwriters' Laboratories, Inc. (U.L.) and shall bear the listing label. Electrical equipment shall, where a listing is normal for the particular class of equipment, be listed in the *Electrical Appliance and Utilization Equipment List* of the Underwriters' Laboratories, Inc. (U.L.) and shall bear the listing label. Materials and equipment listed and labeled as "approved for the purpose" by other nationally recognized testing laboratory, inspection agency or approved organization (such as E.T.L. or Factory Mutual) shall be acceptable.

1.11 SUBMITTALS

A. Product Data: For items specified in Part 2 of this Section.

1.12 SUBMITTALS, REVIEW AND ACCEPTANCE

A. Equipment, materials, installation, workmanship and arrangement of work are subject to review and acceptance. No substitution will be permitted after acceptance of equipment or materials except where such substitution is considered by the Engineer to be in best interest of Owner.

B. After acceptance of Material and Equipment List, submit six (6) copies, or more as required under the General Conditions, of complete descriptive data for all items. Data shall consist of specifications, data sheets, samples, capacity ratings, performance curves, operating characteristics, catalog cuts, dimensional drawings, wiring diagrams, installation instructions, and any other information necessary to indicate complete compliance with Contract Documents. Edit submittal data specifically for application to this project.

C. Thoroughly review and stamp all submittals to indicate compliance with contract requirements prior to submission. Coordinate installation requirements and any electrical requirements for equipment submitted. Contractor shall be responsible for correctness of all submittals.

D. Submittals will be reviewed for general compliance with design concept in accordance with Contract Documents, but dimensions, quantities, or other details will not be verified.

E. Identify submittals, indicating intended application, location and service of submitted items. Refer to specification sections or paragraphs and drawings where applicable. Clearly indicate exact type, model number, style, size and special

features of proposed item.

F. Submittals of a general nature will not be acceptable. For substituted items, clearly list on the first page of the submittal all differences between the specified item and the proposed item. The Contractor shall be responsible for corrective action and maintaining the specification requirements if differences have not been clearly indicated in the submittal.

G. Submit actual operating conditions or characteristics for all equipment where required capacities are indicated. Factory order forms showing only required capacities will not be acceptable. Call attention, in writing, to deviation from contract requirements.

H. Acceptance will not constitute waiver of contract requirements unless deviations are specifically indicated and clearly noted. Use only final or corrected submittals and data prior to fabrication and/or installation.

I. For any submittal requiring more than two (2) reviews by the Engineer (including those caused by a change in subcontractor or supplier) the Owner will withhold Contractor's funds by a change order to the contract to cover the cost of additional reviews. One review is counted for each action including rejection or return of any reason.

1.13 SHOP DRAWINGS

A. Prepare and submit Shop Drawings for all electrical equipment, specially fabricated items, modifications to standard items, specially designed systems where detailed design is not shown on the Contract Drawings, or where the proposed installation differs from that shown on Contract Drawings.

B. Submit Data and Shop Drawings including but not limited to the list below, in addition to provisions of the paragraph above. Identify all shop drawings by the name of the item and system and the applicable Specification paragraph number and Drawing number.

C. Every submittal including, but not limited to the list below, shall be forwarded with its own transmittal as a separate, distinct shop drawing. Grouping of items/systems that are not related shall be unacceptable.

Items and Systems

1. Access Doors
2. Analysis & Coordination Study
3. Arc Flash Hazard Analysis
4. Arc Flash Hazard Labels
5. Battery Packs for Lighting Fixtures
6. Conductors and Cables - 600V or Less
7. Conduit and Raceway
8. Disconnect (Safety) Switches - Fused/Non-Fused
9. Electrical Connection Coordination Schedule
10. Electricity Meter
11. Emergency Off Push-Buttons
12. Enclosed Circuit Breakers
13. Equipment Nameplates/Labels

14. Firestopping Materials
15. Foam Duct Sealant
16. Fuses, 600V or Less
17. Fuses, Medium Voltage
18. Generator
19. Ground Conductors
20. Ground Rods
21. Handholes
22. Hangers and Supports
23. Identification Products
24. Installation/Coordination Drawings of Electrical Room Layouts
25. Installation/Coordination Drawings of Mechanical Room Layouts
26. Installation/Coordination Drawings of Other Spaces as indicated in the Specifications
27. Junction and Pull Boxes, Custom Sizes
28. Junction and Pull Boxes, Standard Sizes
29. Lighting Contactors
30. Lighting Control Panels
31. Lighting Fixtures, Exterior
32. Lighting Fixtures, Interior
33. Lightning Protection System Wiring Diagrams
34. Lightning Protection System Product Data
35. Lightning Protection System Shop Drawings
36. Motor Controllers
37. Motor Starters
38. Operation and Maintenance Manual
39. Outlet and Device Boxes
40. Panelboard Circuit Directories
41. Panelboards
42. Photocells
43. Receptacles (Hospital Grade)
44. Record Drawings
45. Sleeve Seals
46. Sleeves
47. Surface Metal Raceway
48. Surface Non-Metallic Raceway
49. Surge Protective Devices
50. Switchboards
51. Testing Agency Qualifications
52. Tests and Reports
53. Toggle/Snap Switches (Hospital Grade)
54. Transfer Switches, Automatic
55. Transformers, 600V and Less
56. Underground Ductbank Products
57. Wiring Diagrams

D. Submittals shall include but not be limited to the following information: size, type, functional characteristics, compliance with standards in Division 26, required service access which shall be suitable for intended location and use, electrical service connections and requirements, and deviations from Contract Documents requirements.

E. Submit for approval any other shop drawings as required by the Engineer. No item listed above shall be delivered to the site, or installed, until approved. After the proposed materials have been approved, no substitution will be permitted except where approved by the Engineer.

F. Submittals shall include Riser Diagrams and Schematic Wiring Diagrams, complete conduit and wire requirements, outlet and junction box sizes and power requirements, for the following systems:

1. Grounding and Bonding System
2. Lightning Protection System

G. For any shop drawing requiring more than two (2) reviews by the Engineer (including those caused by a change in subcontractor or supplier) the Owner will withhold Contractor's funds by a change order to the contract to cover the cost of additional reviews. One review is counted for each action including rejection or return for any reason.

H. Prepare and submit a detail schedule of values indicating the Contract costs for the major work items. Provide additional detail and information as requested by the Engineer.

1.14 SUBSTITUTIONS

A. Substituted item 'or items' other than those named shall be equal or better in quality and performance and must be suitable for the available space, required arrangement, and application. Submit any and all data necessary to determine the suitability of substituted items. Be responsible for correct application, placement, and installation of substituted equipment. Cost savings data shall also be submitted with submittal data for substituted items. Total cost savings or a per unit saving to the Owner shall be clearly indicated. If a substituted item is accepted, all cost savings shall be returned to the Owner as a credit.

B. Substitutions will not be permitted for specific items of material or equipment unless specifically indicated.

C. For substituted items, clearly list on the first page of the submittal all differences between the specified item and the proposed item. Be responsible for corrective action (or replacement with the specified item) while maintaining the specification requirements if differences have not been clearly indicated in the submittal.

D. Where proposals to use an item of equipment or application other than that specified or detailed on the Drawings, which requires any redesign of the structure, partitions, foundation, HVAC, piping, wiring, or any other part of the mechanical, electrical, or architectural layout, all such redesign and all new drawings and detailing required thereafter shall be prepared by the Contractor at his own expense for review by the Owner's representative before any such work is implemented.

E. All Contractor-proposed changes and revisions shall be at the Contractor's risk and expense. The Contractor shall fully coordinate all revisions, substitutions and changes with other trades. The Contractor shall provide all necessary provisions,

including HVAC, ventilation, foundations, access, etc., for a complete, code compliant, and fully functional installation.

F Where the submission of substitution for equipment or materials is made:

1. Submit Shop Drawings that show complete compliance to each statement or requirement of the Specifications.

2. Submit certified test data from an independent testing laboratory for each product.

3. Submit one complete working sample of the equipment or materials to be furnished. In cases involving large or heavy items of equipment, the Owner may waive the requirement to submit the sample.

G. Failure to comply with the above-required submissions shall constitute an automatic rejection of the substitution.

1.15 DEFINITIONS

A. *Approve:* To permit use of material, equipment or methods conditional upon compliance with contract documents requirements.

B. *Building Line:* Exterior wall of building.

C. *Concealed:* Hidden from sight in chases, formed spaces, shafts, hung ceilings, embedded in construction or in crawl space or attic.

D. *Conduits* include conduit, all fittings, identification, and other accessories relative to such conduit.

E. *Contractor:* The electrical contractor and any of his subcontractors, vendors, suppliers, or fabricators.

F. *EPDM:* Ethylene-propylene-diene terpolymer rubber.

G. *Exposed:* Not installed underground or *concealed* as defined above.

H. *Finished Spaces:* Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceiling, unexcavated spaces, crawl spaces, and tunnels.

I. *Furnish and install* or *provide:* To supply, erect, install, and connect to complete for readiness for regular operation, the particular work referred to.

J. *Location, Damp:* Locations protected from water and not subject to saturation with water or other liquids, but subject to moderate degrees of moisture. Examples of such locations include interior locations such as basements, crawlspaces, attics, cold-storage rooms, etc...

K. *Location, Dry:* A location not normally subject to dampness or wetness. A dry location may temporarily be subject to dampness or wetness during building construction.

L. *Location, Wet:* Locations subject to saturation with water or other liquids, locations exposed to weather, and installations underground or in concrete slabs or masonry in direct contact with the Earth. Examples of such locations include all exterior locations (including those under canopies, roofed open porches, etc...) commercial kitchens, and vehicle washing areas.

M. *NBR:* Acrylonitrile-butadiene rubber.

N. *Review:* Limited observation or checking to ascertain general conformance with design concept of the work and with information given in contract documents. Such action does not constitute a waiver or alteration of the contract requirements.

1.16 RECORD DRAWINGS

A. Upon completion of the electrical installations, the Contractor shall deliver to the Engineer one complete set of prints of the electrical Contract Drawings which shall be legibly marked in red pencil to show all changes and departures of the installation as compared with the original design. They shall be suitable for use in preparation of Record Drawings.

B. Contractor shall incorporate all sketches, addendums, value engineering, change orders, etc., into Record Drawings prior to delivering the same to the Architect.

1.17 WARRANTY

A. Contractor's attention is directed to warranty obligations contained in the General Conditions.

B. The above shall not in any way void or abrogate equipment manufacturer's guarantee or warranty. Certificates of equipment manufacturer's warranties shall be included in the operations and maintenance manuals.

C. The Contractor guarantees for a two year period from the time of final acceptance by the Owner:

1. That the work contains no faulty or imperfect material or equipment or any imperfect, careless, or unskilled workmanship.

2. That all work, equipment, machines, devices, etc. shall be adequate for the use to which they are intended, and shall operate with ordinary care and attention in a satisfactory and efficient manner.

3. That the Contractor will re-execute, correct, repair, or remove and replace with proper work, without cost to the Owner, any work found to be deficient. The Contractor shall also make good all damages caused to their work or materials in the process of complying with this section.

4. That the entire work shall be water-tight and leak-proof.

1.18 OPERATIONS AND MAINTENANCE MANUALS

A. The Contractor shall have prepared three (3) copies of the Record and Information Booklet and deliver these copies of the booklet to the Owner. The booklet shall be as specified herein. The booklet must be approved and will not be accepted as final until so stamped.

B. The booklet shall be bound in a three-ring loose-leaf binder similar to National No. 3881 with the following title lettered on the front: *Operations and Maintenance Manuals [project name J - Electrical.* No sheets larger than 8-1/2 inches x 11 inches shall be used, except sheets that are neatly folded to 8-1/2 inches x 11 inches and used as a pull-out. Provide divider tabs and table of contents for organizing and separating information.

C. Provide the following data in the booklet:

1. As first entry, an approved letter indicating the starting/ending time of Contractor's warranty period.
2. Maintenance operation and lubrication instructions on each piece of equipment furnished.
3. Complete catalog data on each piece of electrical equipment furnished including approved Shop Drawing/Submittal with Engineer's comments (if any).
4. Manufacturer's extended limited warranties on equipment.
5. Provide sales and authorized service representatives names, address, and phone numbers of all equipment and subcontractors.
6. Provide supplier and subcontractor's names, address, and phone number.
7. Catalog data of all equipment, starters, etc. shall include wiring diagrams, parts list and assembly drawing.
8. Access panel charts with index illustrating the location and purpose of access panels.
9. Approved Electrical Certificates.
10. Start-up reports for equipment.

D. Submit Record and Information Booklets prior to anticipated date of Substantial Completion for Engineer review and approval. Substantial Completion requires that Record and Information booklets be reviewed and approved.

E. Post one (1) copy of all instructions, lists, charts and diagrams at the equipment mounted under glass or approved plastic cover.

F. Deliver all instruction materials to the Owner prior to the formal instruction period.

G. Upon completion of all work, thoroughly instruct the Owner's representatives in the proper operation and maintenance of all electrical equipment and systems.

H. Instructions shall be done only after completed systems have been put into operation and tested for proper operation and performance.

I. Instructions shall be given only by experts in the equipment or system and shall include descriptions and demonstrations of procedures of operation, data record keeping, etc.

J. Furnish the necessary technicians, skilled workers, and helpers to operate the electrical systems and equipment of the entire project for one 8-hour day.

K. Where specified in technical sections, provide longer periods required for specialized equipment.

L. Instruct the Owner or designated personnel in operation, maintenance, lubrication, and adjustment of systems and equipment.

M. The Operating and Maintenance Manual shall be available at the time of the instructions for use by Instructors and Owner personnel.

O. Schedule the general and specialized instruction periods for a time agreed upon by the Owner and Engineer.

1.19 INSTALLATION AND COORDINATION DRAWINGS

A. Prepare, submit and use composite installation and coordination drawings to assure proper coordination and installation of the work. Drawings shall include, but not be limited to the following:

1. Mechanical Rooms indicating transformers, panelboards, enclosures, boxes, conduits, mechanical equipment, ductwork, and piping, etc...

2. Electrical Rooms indicating switchboards, transformers, panelboards, enclosures, boxes, conduits, wireways, etc...

B. Draw plans to a scale not less than 'A inch equals one foot. Include plans, sections and elevations of the proposed work, showing all equipment (mechanical, plumbing and electrical), conduit and wiring in the areas involved. Fully dimension all work, horizontally and vertically. Show coordination with other work including piping, ductwork and other mechanical work, walls, doors, ceilings, columns, beams, joists and other architectural and structural work.

C. Identify all equipment and devices on wiring diagrams. Where field connections are shown to factory-wired terminals, furnish manufacturer's literature showing internal wiring of equipment.

D. Prepare, submit, and use scaled layout drawings indicating dimensions, clearances, and actual equipment dimensions. Layout drawings shall include, but not be limited to the following:

1. Pad-mounted equipment and equipment connections.

2. Underground conduits, ductbanks, and building penetrations.

E. Prepare scaled coordination drawings in accordance with the Specifications. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

Indicate the proposed locations of power, lighting, and all special system raceways, equipment, and materials. Include the following:

1. Working spaces and dedicated space clearances per the NEC.

2. Clearances for equipment disassembly required for periodic maintenance.

3. Exterior wall and foundation penetrations.

4. Fire-rated wall and floor penetrations.

5. Equipment connections and support details.

F. Sizes and locations of required concrete bases.

1. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction, including, but not limited to, the following: Major conduits and feeders.

2. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

3. The successful Bidder shall be responsible for indicating all raceways described in notes or indicated by home run symbols.

4. The successful Bidder shall check all trades' Drawings, including Civil, Architectural, Structural, Plumbing, and Mechanical to avoid possible demolition and installation conflicts.

G. For any installation and coordination drawings requiring more than two (2) reviews by the Engineer (including those caused by a change in subcontractor or supplier) the Owner will withhold Contractor's funds by a change order to the contract to cover the cost of additional reviews. One review is counted for each action including rejection or return of any reason.

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron

pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:

A. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).

B. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 nun).

2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM and NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.

3. Pressure Plates: Carbon steel. Include two for each sealing element.

4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.4 FOAM DUCT SEALANT

A. Description: Two-part, high-expansion foam duct sealant to keep water, acids, dust, gases, insects and rodents out of ducts (conduits).

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited

to the following:

1. American Polywater Corporation

C. Basis of Design: FST Foam Sealant by American Polywater Corporation.

D. The foam duct sealant shall be a two-part "blown" urethane foam with 98% closed cell content.

E. The foam duct sealant shall have a compressive strength of 300 pounds (ASTM D1691), a ten sile strength of 250 pounds (ASTM D1623), and a flexural strength of 450 pounds (ASTM D790).

F. The foam duct sealant shall be compatible with common cable jacket materials. The cured foam shall be an inert solid that does not affect jacket materials.

G. The foam duct sealant shall withstand temperatures from -20 degrees Fahrenheit to 200 degrees Fahrenheit and shall not lose function in direct sunlight

H. The foam duct sealant shall be chemically resistant to gasoline, oils, dilute acids and bases, and most unsaturated hydrocarbons.

I. The foam duct sealant shall foam and react in five to ten minutes at 70 degrees Fahrenheit.

J. When installed, the sealant shall be capable of holding 7.25 psi air pressure continuously (equivalent of 16.4 feet water-head pressure).

2.5 PLYWOOD BACKBOARDS

A. 4'x8'x 3/4" thick AC grade or better fire-retardant plywood.

B. Backboards shall be painted with a minimum of two coats of flame retardant paint to match adjacent wall color.

2.6 FASTENERS

A. All fasteners located in public spaces including corridors, lobbies, toilet rooms, etc., shall be provided with tamper proof fasteners. Provide Pin Phillips hardware as manufactured by Challenge Industries or approved equal.

PART 3 - EXECUTION

3.1 TEMPORARY FACILITIES

A. General: Refer to the Division 1 Sections for general requirements of temporary facilities.

B. Description: Furnish and install the necessary metering and distribution equipment for an adequate, 3-phase, 4-wire temporary electrical service and all temporary wiring, including step-down or step-up dry-type transformers as required. Exact

requirements for temporary service will be determined by the General Contractor.

C. Attention is directed to the Occupational Safety and Health Act (OSHA), Americans with Disabilities Act (ADA) and National Electrical Code (NEC) requirements for electrical work on construction sites.

D. Materials:

1. Lights at each floor in each stair. At least one light outlet per 900 square feet on each floor exclusive of stairs.

2. One 20-ampere circuit with ground fault protection for each 7500 square feet of gross floor area per floor to which various trades may attach their cords.

3. One temporary power line in each corridor elevator and lobby, including connections to saws, if required, with ground fault protection.

4. Power for testing and operating of elevators.

5. Temporary lighting for stripping forms for all floors below grade.

6. Power for crane operation if required.

E. Installation: Temporary lighting shall provide minimum foot candle levels for construction as follows:

AREA	FOOT CANDLE LEVEL
General construction area lighting, corridors, hallways and exit ways.	10
Electrical equipment rooms, active storerooms, shops, locker and dressing areas	15

F. The Contractor shall pay for all energy charges for temporary service.

G. Obtain and pay for temporary electrical service for construction power.

H. Provide temporary construction power as dictated at the Pre-Bid Meeting by the General Contractor.

I. Provide all underground and/or overhead equipment, transformers, overcurrent devices, wires, connections, etc., for obtaining power from utility company lines.

J. Remove all temporary power installations and connections after permanent power is established and/or prior to completion of the project.

3.2 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Comply with NEC Article 517.

C. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

D. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

E. Install equipment with working space and dedicated space in strict accordance with 2011 NEC Article 110.26.

F. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

G. Install equipment according to approved submittal data. Portions of the work are shown only in diagrammatic form. Refer conflicts to Architect and Engineer.

H. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

I. Install equipment giving right of way to piping installed at required slope.

J. Verify exact electrical service requirements for each piece of equipment receiving electrical connections. Provide proper service for each.

K. Include any and all items required by the National Electrical Code and/or field conditions for the proper connection and installation of each piece of equipment.

L. Coordinate electrical work with architectural items and equipment by others. Typical equipment refers to, but is not limited to, the following:

1. Countertops, Casework and Cabinets.

    a. Do not install outlets, switches, etc., behind casework, cabinets, etc.
    b. Data, phone, and other low voltage system outlets shall be mounted above the counter tops to match power outlets in the same areas.
    c. Coordinate counter top outlets with drilling of casework/counters.
    d. Coordinate surface raceways and outlets above and below counters with approved casework shop drawings to avoid conflicts with sinks and other appurtenances.

2. Kitchen Equipment.

    a. Verify kitchen equipment nameplates and connection requirements prior to rough-in.
    b. Fans and Exhaust Hoods.

c. Dishwasher Hoods and Fans.

3. Exam Rooms, Specialties Rooms, etc. Equipment.

a. Verify equipment nameplates and connection requirements prior to rough-in.
b. Exhaust Hoods and Fume Hoods.

3.3 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.

G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements of Division [07] Section "Joint Sealants."

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements of Division 07 Section "Penetration Firestopping".

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals. Seal interior of each raceway with Foam Duct Sealant as specified herein.

N. Cut sleeves to length for mounting flush with both surfaces of walls.

3.4 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.5 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 7 Section "Penetration Firestopping".

3.6 SUPPORTS, HANGERS AND FOUNDATIONS

A. Provide supports, hangers, braces, attachments and foundations required for the work. Support and set the work in a thoroughly substantial and workmanlike manner without placing strains on materials, equipment, or building structure, submit shop drawings for approval. Coordinate all work with the requirements of the structural division.

B. Supports, hangers, braces, and attachments shall be standard manufactured items or fabricated structural steel shapes. All interior hangers shall be galvanized or steel with rust inhibiting paint. All exterior hangers shall be constructed of stainless steel utilizing stainless steel rods, nuts, washers, bolts, etc.

C. Installing Equipment Foundations (Housekeeping Pads):

1. Provide 4.0 inch high concrete foundations (housekeeping pads) for all floor-mounted equipment extending a minimum of 6 inches beyond equipment bases for interior equipment and a minimum of 12 inches beyond equipment bases for exterior equipment, unless otherwise noted. Furnish foundations, bolts, sleeves, and appurtenances and set under the section furnishing the equipment. Anchor the concrete foundations by dowels inserted into the floor slab. Provide welded wire fabric reinforcement, chamfer exposed edges and corners, and fusible exposed surfaces smooth.

2. Unless otherwise specified, provide all concrete work required in accordance with the requirements of Division 3.

3. Equipment shall be properly aligned. Level and grout equipment where necessary. Support conduit independently of equipment and so as not to cause a strain or thrust.

4. Determine exact location of all equipment, foundations, and supports after Shop Drawings of equipment have been approved.

D. Where new concrete housekeeping pads are placed on existing concrete, saw cut the existing concrete to the perimeter dimension of the new pad to a depth of '/2 inch. Break out the top'/ inch area of the existing concrete. Add stubs of #4 rebar angled into the existing concrete at a depth of approximately 50 percent of the existing slab thickness. The top portion of the rebar stub shall extend into the new pad by approximately 50 percent of its thickness. Furnish one rebar stub per every two square feet of new pad. Chemically bond the new concrete to the existing concrete.

3.7 PROVISIONS FOR ACCESS

A. The Contractor shall provide access panels and doors for all concealed equipment, and other devices requiring maintenance, service, adjustment or manual operation.

B. Where access doors are necessary, furnish and install manufactured painted steel door assemblies consisting of hinged door, key locks, and frame designed for the particular wall or ceiling construction. Properly locate each door. Door sizes shall be a 12 inches x 12 inches for hand access, 18 inches x 18 inches for shoulder access and 24 inches x 24 inches for full body access where required. Review locations and sizes with Architect prior to fabrication. Provide U.L. approved and labeled access doors where installed in fire rated walls or ceilings. Doors shall be Milcor Metal Access Doors as manufactured by Inland-Ryerson, Mifab, or approved equal.

1. Acoustical or Cement Plaster: Style B
2. Hard Finish Plaster: Style K or L
3. Masonry or Dry Wall: Style M

C. Where access is by means of liftout ceiling tiles or panels, mark each ceiling grid using small color-coded and numbered tabs. Provide a chart or index for identification. Place markers within ceiling grid <u>not</u> on ceiling tiles.

D. Access panels, doors, etc. described herein shall be furnished under the section of specifications providing the particular service and to be turned over to the pertinent trade for installation. Coordinate installation with installing Contractor. All access doors shall be painted in baked enamel finish to match ceiling or wall finish.

E. Access panels in security or detention areas shall be security type.

F. Submit shop drawings indicating the proposed location of all access panels/doors. Access doors in finished spaces shall be coordinated with air devices, lighting and sprinklers to provide a neat and symmetrical appearance.

3.8 PAINTING AND FINISHES

A. Provide protective finishes on all materials and equipment. Use coated or corrosion- resistant materials, hardware and fittings throughout the work. Paint bare, untreated ferrous surfaces with rust-inhibiting paint. All exterior components including supports, hangers, nuts, bolts, washers, vibration isolators, etc. shall be stainless steel.

B. Clean surfaces prior to application of insulation, adhesives, coatings, paint, or other finishes.

C. Provide factory-applied finishes where specified. Unless otherwise indicated factory- applied paints shall be baked enamel with proper pretreatment.

D. Protect all finishes and restore any finishes damaged as a result of work under Division 26 to their original condition.

E. The preceding requirements apply to all work, whether exposed or concealed, as defined.

F. Remove all construction marking and writing from exposed equipment, ductwork, piping and building surfaces. Do not paint manufacturer's labels or tags.

G. All exterior roof mounted equipment, and conduits shall be painted to match roof in color as selected by Architect.

H. All exposed conduit, equipment, etc. in finished spaces shall be painted. Colors shall be as selected by the Architect and shall conform to ANSI Standards.

3.9 COLOR SELECTION

A. Color of finishes shall be as selected by the Architect.

3.10 PROTECTION OF WORK

A. Protect work, material and equipment from weather and construction operations before and after installation. Properly store and handle all materials and equipment.

B. Cover temporary openings in conduits and equipment to prevent the entrance of water, dirt, debris, or other foreign matter. Deliver conduits with factory applied end caps.

C. Cover or otherwise protect all finishes.

D. Replace damaged materials, devices, finishes and equipment.

E. Protect stored conduits from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, where stored inside.

3.11 OPERATION OF EQUIPMENT

A. Clean all systems and equipment prior to initial operation for testing, or other purposes. Lubricate, adjust, and test all equipment in accordance with manufacturer's instructions. Do not operate equipment unless all proper safety devices or controls

are operational. Provide all maintenance and service for equipment that is authorized for operation during construction.

B. Where specified, or otherwise required, provide the services of the manufacturer's factory-trained servicemen or technicians to start up the equipment. Where factory start-up of equipment is not specified, provide field start-up by qualified technician.

C. Submit factory start-up sheets or field start-ups sheets for all equipment prior to the commencement of testing.

D. Do not use electrical systems for temporary services or during construction, unless approved by Owner in writing. Refer to Division 1 Section "Temporary Facilities and Controls".

E. Upon completion of work, clean and restore all equipment to new conditions; replace expendable items.

3.12 TESTING AND ADJUSTMENT

A. Perform all tests which are specified or required to demonstrate that the work is installed and operating properly. Where formal tests are required, give proper notices and perform all necessary preliminary tests to assure that the work is complete and ready for final test.

B. Adjust all systems, equipment and controls to operate in a safe, efficient and stable manner.

C. On all circuits, 600 volts or less, provide circuits that are free from ground faults, short circuits and open circuits.

D. Other tests of a specific nature for special equipment shall be as specified under the respective equipment.

E. Submit all test results to the Engineer for approval.

3.13 WALL AND FLOOR PENETRATIONS

A. All penetrations of partitions, ceilings, roofs and floors by or conduit under Division 26 shall be sleeved, sealed, and caulked airtight for sound and air transfer control. Penetrations of mechanical room partitions, ceilings, and floors shall be as specified in Division 26.

B. All penetrations of fire rated assemblies shall be sleeved, sealed, caulked and protected to maintain the rating of the wall, roof, or floor. Fire Marshal approved U.L. assemblies shall be utilized. See Division 26 Section, "Electrical Firestopping".

C. Where piping extends through exterior walls or below grade, provide waterproof pipe penetration seals, as specified in another division of these specifications.

D. Provide conduit escutcheons for are exposed conduit penetrations in finished interior

spaces and all exposed exterior penetrations. Escutcheons shall match those provided under Division 23.

E. Conduit sleeves:

1. Galvanized steel pipe, standard weight where pipes are exposed and roofs and concrete and masonry walls. On exterior walls provide anchor flange welded to perimeter.

2. Twenty-two (22) gauge galvanized steel elsewhere.

3.14 EQUIPMENT BY OTHERS

A. This Contractor shall make all system connections required to equipment furnished and installed under other divisions or furnished by the Owner. Connections shall be complete in all respects to render this equipment functional to its fullest intent.

B. It shall be the responsibility of the supplier of the equipment to furnish complete instructions for connections. Failure to do so will not relieve the Contractor of any responsibility for improper equipment operation.

3.15 PHASING

A. Refer to Architectural Specifications and Contract Drawings for any required phasing.

B. Maintain building egress and traffic ways at all times. Coordinate egress requirements with the State Fire Marshal, the Owner and Authorities having jurisdiction.

C. Provide dust barriers/partitions, penetration closures, etc., to ensure safety of building occupants and protection of existing surroundings.

D. The Building shall remain watertight at all times.

E. Refer to phasing plans for additional requirements.

F. Within thirty days of Award of Contract, the Contractor shall submit a minimum of six (6) copies of the proposed Phasing Plan (Drawings and detailed written description) to the Architect for review and approval based on the general and specific requirements indicated on the Drawings and Specifications. The phasing plan shall reflect the work of all trades. The phasing plan shall be updated as often as needed (i.e. major deviations and/or modified sequence of events) and reviewed during each progress meeting so the facility and Architect can be aware of the areas of construction and progress as it relates to the approved schedule.

G. While work is in progress, except for designated short intervals during which connections are made, continuity of service shall be maintained to all existing systems. Interruptions shall be coordinated with the Owner as to time and duration. The Contractor shall be responsible for any interruptions to service and shall repair any damages to existing systems caused by his operations.

3.16 OUTAGES

A. Provide a minimum of fourteen (14) days notice to schedule outages. The Contractor shall include in their bid outages and/or work in occupied areas to occur on weekends, holidays, or at night. Coordinate and get approval of all outages with the Owner.

B. Submit *Outage Request Form,* attached at the end of this Section, to Owner for approval.

3.17 CUTTING AND PATCHING

A. Accomplish all cutting and patching necessary for the installation of work under Division 26. Damage resulting from this work to other work already in place, shall be repaired at Contractor's expense. Where cutting is required, perform work in neat and workmanlike manner. Restore disturbed work to match and blend with existing construction and finish, using materials compatible with the original. Use mechanics skilled in the particular trades required.

B. Do not cut structural members without approval from the Architect or Engineer.

3.18 PENETRATION OF WATERPROOF CONSTRUCTION

A. Coordinate the work to minimize penetration of waterproof construction, including roofs, exterior walls, and interior waterproof construction. Where such penetrations are necessary, furnish and install all necessary curbs, sleeves, flashings, fittings and caulking to make penetrations absolutely watertight.

B. Where conduits penetrate roofs, flash pipe with Stoneman *Stormtite,* Pate or approved equal, roof flashing assemblies with skirt and caulked counter flashing sleeve.

C. Furnish and install pitch pockets or weather tight curb assemblies where required.

D. Furnish and install roof drains, curbs, vent assemblies, and duct sleeves specifically designed for application to the particular roof construction, and install in accordance with the manufacturer's instructions. The Contractor shall be responsible for sleeve sizes and locations. All roof penetrations shall be installed in accordance with manufacturer's instructions, the National Roofing Contractors Association, SMACNA, and as required by other divisions of these specifications.

3.19 CONCRETE AND MASONRY WORK

A. Furnish and install concrete and masonry work for equipment foundations, supports, pads, and other items required under Division 26. Perform work in accordance with requirements of Division 3 and other applicable Divisions of these Specifications.

B. Concrete shall test not less than 3,000 psi compressive strength after 28 days.

C. Grout shall be non-shrink, high strength mortar, free of iron of chlorides and suitable for use in contact with all metals, without caps or other protective finishes. Apply in accordance with manufacturer's instructions and standard grouting practices.

D. Installing Outdoor Equipment Foundations:

1. Provide equipment foundations of size and thickness as indicated.

2. Place reinforcement accurately in position shown, securely fasten and support to prevent displacement before or during pouring. Clean, bend, place, and splice reinforcement in accordance with approved shop drawings. Lap ends and sides of mesh reinforcement in slabs not less than one inch. Coverage of main reinforcing shall be as follows:

   A. Slabs - 3/4 inch
   B. Concrete poured against earth - 3 inches
   C. Other locations - 2 inches

3. Properly align, level, and grout all equipment where necessary.

3.20 CONNECTIONS AND ALTERATIONS TO EXISTING WORK

A. Unless otherwise noted on the Drawings, where existing electrical work is removed, including hangers, to a point below finished floors or behind finished walls and capped, such point shall be far enough behind finished surfaces to allow for installation of normal thickness of required finish material.

B. Where work specified in Division 26 connects to existing equipment, conduits, etc., Contractor shall perform all necessary alterations, cuttings, fittings, etc., of existing work as may be necessary to make satisfactory connections between new and existing work, and to leave completed work in a finished and workmanlike condition.

C. Where the work specified under Division 26, or under other Divisions, requires relocation of existing equipment, conduit etc., Contractor shall perform all work and make necessary changes to existing work as may be required to leave completed work in a finished and workmanlike condition. Where existing insulation is disturbed, replace insulation where removed or damaged equal to existing, in type, thickness, density, finish and thermal resistance (R-value) value.

D. Where the relocation of existing equipment is required for access or the installation of new equipment, the Contractor shall temporarily remove and/or relocate and re-install as required to leave the existing and new work in a finished and workman like condition.

3.21 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.

2. To provide for ease of disconnecting the equipment with minimum interference to other installations.

3. To allow right of way for piping and conduit installed at required slope.

4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

5. To provide working space and dedicated space clearances per 2011 NEC Article 110.26.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 8 Section "Access Doors and Frames".

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Penetration Firestopping".

3.22 DEMOLITION

A. Where existing equipment is indicated to be removed, all associated conduit, power, controls, insulation, hangers, supports and housekeeping pads, etc., shall also be removed. Patch, paint and repair walls/roof/floor to match existing and/or new finishes.

B. The Contractor shall be responsible for visiting the site and determining the existing conditions in which the work is to be performed.

C. Refer to phasing plans for additional requirements.

D. Where any abandoned conduits in existing floors, walls, pipe tunnels, ceilings, etc., conflict with new work, remove abandoned conduits as necessary to accommodate new work.

E. Maintain egress at all times. Coordinate egress requirements with the State Fire Marshal, the Owner and the Authorities Having Jurisdiction (AHJ).

F. Make provisions and include in bid all costs associated with confined entry/space requirements in crawl spaces and all other applicable OSHA and MOSHA regulations.

I. Where required to maintain the existing systems in operation, temporarily backfeed existing systems from new equipment. Contractor shall temporarily extend existing conduit systems to new conduit systems.

J. At completion of project all temporary conduit, wires, etc., shall be removed in their entirety.

K. Existing conduit, equipment, wiring, etc., not required for re-use or re-installation in this project shall be removed from the project site.

L. Deliver to the Owner, on the premises where directed, existing equipment and materials which are removed and which are desired by the Owner or are indicated to remain the

property of the Owner.

M. All other materials and equipment which are removed shall become property of the Contractor and shall be promptly removed, from the premises, and disposed of by the Contractor, in an approved manner. Contractor shall be responsible for proper disposal of all removed equipment containing PCB's.

N. Where conduit and wiring are removed, remove all conduit hangers which were supporting the removed conduit. Patch the remaining penetration voids with like materials and paint to match existing construction.

O. Before demolition begins, and in the presence of the Owners representative, test and note all deficiencies in all existing systems affected by demolition but not completely removed by demolition. Provide a copy of the list of system deficiencies to the Owner and the Engineer. Videotape existing conditions in each space prior to beginning demolition work.

P. The Owner shall have the first right of refusal for all fixtures, devices and equipment removed by the Contractor.

Q. All devices and equipment designated by the Owner to remain the property of the Owner shall be moved and stored by the Contractor at a location on site as designated by the Owner. It shall be the Contractor's responsibility to store all devices and equipment in a safe manner to prevent damage while stored.

R. All existing equipment refused by the Owner shall become the property of the Contractor and shall be removed from the site by the Contractor in a timely manner and disposed of in a legal manner.

S. Work Abandoned in Place: Cut and remove conduit a minimum of 2 inches beyond face of adjacent construction. Cap and patch surface to match existing finish.

T. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

U. Terminate services and utilities in accordance with local laws, ordinances, rules and regulations.

3.23 EXCAVATION AND BACKFILLING

A. General:

1. Perform all necessary excavation, or installation of work under Division 26, in whatever materials or conditions encountered, using suitable methods and equipment.

2. Accurately establish required lines and grades and properly locate the work.

3. Determine the locations of all existing utilities before commencing the work.

B. Excavation: (Refer also to other portions of the Specifications)

1. Excavate only the required elevations. If excavation is carried below the foundation lines or other required limits, backfill the excess with concrete.

2. Keep banks of trenches as nearly vertical as possible, and provide sheeting and/or shoring as required for protection of work and safety of personnel. Follow local, State, OSHA, and MOSHA Guidelines.

3. Keep excavations dry. Protect excavations from freezing.

C. Backfilling: (Refer also to other portions of the Specifications)

D. Backfill excavations to the required elevations and restore surfaces to their original or required conditions.

1. Backfill shall be similar material, free from objectionable matter such as rubbish, roots, stumps, brush, rocks and other sharp objects. Unless otherwise indicated, suitable material from the excavation may be used for backfill.

2. Carefully place and mechanically tamp backfill in layers not exceeding 12 inches loose thickness. Compact to 95 percent minimum.

3. Do not backfill against frozen material. Do not use frozen material for backfill.

END OF SECTION 260500

OUTAGE REQUEST

DATE APPLIED: BY: _____

DATE FOR OUTAGE: _____ FIRM: _____

START OUTAGE-TIME: _____ DATE: _____

END OUTAGE -- TIME: _____ DATE: _____

AREAS AND ROOMS: _____

FLOOR(S): _____

AREA(S): _____

ROOM(S): _____

WORK TO BE PERFORMED: _____

SYSTEM(S): _____

REQUEST APPROVED BY: _____
(FOREMAN OR OTHER PERSON IN CHARGE)

(FOR OWNER'S USE ONLY):

APPROVED: _____

YES ____ NO ___ BY: _____ DATE: _____

DATE/TIME-AS REQUESTED: _____ OTHER : _____

OWNER'S PRESENCE REQUIRED: _____

YES: ____ NO: ____ NAME: _____

POINT OF CONTACT: _____ PHONE: _____

SECTION 260501 - BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections apply to this section.

1.2 SUMMARY

A. This Section includes the following:

1. Concrete equipment bases.
2. Sleeves, seals, and plates.
3. Cutting and patching for electrical construction.
4. Touchup painting.
5. Penetration of waterproof construction.
6. Concrete and Masonry Work.
7. Quiet Operation and Vibration.
8. Provisions for Access.
9. Quality Control.

1.3 QUALITY ASSURANCE

A. 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.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONCRETE BASES

A. Concrete Forms and Reinforcement Materials: As specified in Division 3 Section *Cast-in-Place Concrete.*

B. Concrete: 3000-psi (20.7-MPa). 28-day compressive strength as specified in Division 3 Section *Cast-in-Place Concrete.*

C. Grout:

1. Non-Shrink Grout: Premixed, consisting of non-metallic aggregate, cement, water-reducing and plasticizing agents: capable of developing minimum compressive strength of 7,000 psi in 28 days.

2. Grout shall be as manufactured by:

a. Sonneborn-Rexnord *Sonogrout.*

b. L&M Construction Chemical Company *Crystex.*

c. US Grout Corporation *Five-Star Grout.*

D. Metal Reinforcement:

1. Reinforcing Bars: Deformed steel bars in accordance with ASTM A-615, Grade 60. Clean and free from loose rust, scale, or other coatings that will reduce bond.

2. Welded Wire Fabric Reinforcing: ASTM A185-73 steel wire spot-welded at intersections and of size 6.0 x 6.0 inch mesh. Number six wire.

3. Metal Accessories: Include all spacers, chairs, bolsters, ties, and other devices necessary for properly placing, spacing, supporting, and fastening reinforcement in place.

2.2 TOUCHUP PAINT

A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.

B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

2.3 SLEEVES/SEALS/PLATES

A. Sleeve Inside diameters: Before ordering, fabricating, or installing these sleeves, the Contractor shall determine the required inside diameter of each individual sleeve, and shall provide each sleeve accordingly. The actual inside diameter of each sleeve shall be as required to accommodate the conduit entering or passing through the sleeve, and to assure the watertight installation of the seal specified below. Sleeves shall be flush 22 gauge galvanized steel.

B. Seals: For conduit sleeves, seals shall be *Link-Seal*, as manufactured by Cooper/Crouse-Hinds, Thunderline Corporation, or an approved equal. Seals shall be modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the conduit and the sleeve, with zinc phosphate plated carbon steel bolts, nuts, and pressure plates. Links shall be loosely assembled with bolts to form a continuous rubber belt around the conduit, with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolts shall cause the rubber sealing elements to expand and provide a strictly watertight seal between the pipe and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the conduit and sleeve involved.

C. Sleeves shall be provided for the installation of conduit, etc. The sleeves shall be carefully located in advance of the construction of walls and floors where new construction is involved. Provide all cutting and patching necessary to set sleeves which are not placed prior to construction.

D. Sleeves shall be provided for all conduit, etc. passing through concrete, masonry, construction. Caulk the annular space of sleeves with an elastic fire-resistant caulking compound to make the installation fire, air and water-tight. Provide raceway penetration system equivalent to ProSet Systems System "A" for steel pipe to provide vertical and horizontal support through rated floors and walls in addition to a nominal 2-hour fire rating.

E. Fasten sleeves securely in the construction so that they will not become displaced when concrete is poured or when other construction is built around them. Take precautions to prevent concrete, plaster, or other materials being forced into space between conduit, etc., and sleeve during construction.

F. Sleeves required in existing concrete or masonry walls shall be set and secured with mortar grout and fast drying bitumastic sealant.

G. Seal all the openings between conduit, etc., and corresponding sleeves to prevent sound transmission and to maintain fire rating at all sleeves where objectionable noise can be transmitted: at all smoke barriers: at all walls above ceilings that extend to underside of the structure of floor above, or at fire-rated separations. Use UL approved resilient sealant for penetration seals. Submit method of sealing for approval. Where watertight sleeves are indicated or required to suit the installation, provide *Link-Seal* rubber seals, as manufactured by Thunderline Corporation, or approved equal, between pipe and sleeves.

H. Where conduit motion due to expansion and contraction will occur, make sleeves of sufficient diameter to permit free movement of conduit. Check construction to determine proper length for various locations; make actual lengths.

I. All raceways passing through walls, ceilings, floor and partitions exposed to view shall be provided with approved escutcheons. Sleeves penetrating through rated walls and floors shall be caulked with a fire-proof caulking material so as to not compromise the fire rating.

PART 3 - EXECUTION

3.1 CUTTING AND PATCHING

A. Accomplish cutting and patching necessary for the installation of work under Division 26. Damage resulting from this work to other work already in place shall be repaired at the Contractor's expense. Where cutting is required, perform the work in a neat and workmanlike manner. Restore disturbed work to match and blend with existing, using materials compatible with the original. Use mechanics skilled in the particular trades required.

B. Do not cut structural members.

C. All cutting of walls, floors, roofs, ceilings and/or partitions, handholes for the passage of conduits. etc., and closing up of superfluous openings around them in connection with the work under this Contract, including the removal of all debris caused thereby, shall be

performed.

D. All cutting, patching, and finishing shall be performed by the trade responsible for the type to work to be done in accordance with the requirements of the respective division of the Specifications and shall conform to adjacent work, subject to the approval of the Engineer.

E. Where fireproofing and waterproofing has been removed or damaged in the execution of the work, the Contractor shall have such damage repaired by the respective trades working in the building.

F. Any work already in place that has been disturbed in the execution of the work shall be repaired and restored in harmony with the surrounding work.

G. Provide responsibility for selecting and making all penetrations.

H. All cutting and patching shall conform to the General Conditions. Cutting of walls or floor shall not be done without the written approval of the Owner's Representative.

I. All holes for raceways shall be drilled'-inch larger than the size of the pipe. Space between raceway and hole shall be sealed with grout for masonry work and caulked for dry wall work. Fire ratings shall not be compromised.

3.2 PENETRATION OF WATERPROOF CONSTRUCTION

A. Coordinate the work to minimize penetration of waterproof construction, including roofs, exterior walls, and interior waterproof construction. Where such penetrations are necessary, furnish and install all necessary curbs, sleeves, flashings, fittings, and caulking to make penetrations absolutely watertight.

B. Where conduits or other openings penetrate roofs provide appropriate type of flashing as required by Division 07 - Flashing and Sheetmetal.

C Furnish and install pitch pockets where required.

D. Furnish and install roof drains, curbs, vent assemblies, and conduit/duct sleeves specifically designed for application to the particular roof construction, and install in accordance with the manufacturer's instructions, The National Roofing Contractors' Association, and as required by other divisions of this Specification. Provide responsibility for sleeve sizes and locations.

E. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.

F. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.3 CONCRETE AND MASONRY WORK:

A. Furnish and install concrete and masonry work for equipment foundations, supports, pads,

and other items required under Division 26. Perform work in accordance with requirements of other applicable Divisions of these specifications.

B. Concrete shall test not less than 3,000 psi compressive strength after 28 days.

C. Grout shall be non-shrink, high strength mortar, free of iron of chlorides and suitable for use in contact with all metals, without caps or other protective finishes. Apply in accordance with manufacturer's instructions and standard grouting practices.

D. Submit scaled and dimensioned coordination and layout drawings for all equipment pads, foundations, and supports. Drawings shall indicate equipment access and clearances, pad and equipment dimensions, conduit layouts, and other pertinent information.

E. Installing Equipment Foundations (Housekeeping Pads):

1. Provide 4.0 inch high concrete foundations (housekeeping pads) for all floor-mounted equipment unless otherwise noted, Furnish foundations, bolts, sleeves, and appurtenances and set under the section furnishing the equipment. Anchor the concrete foundations by dowels inserted into the floor slab. Provide welded wire fabric reinforcement.

2. Unless otherwise specified, provide all concrete work required in accordance with the requirements of Division 26.

3. Equipment shall be properly aligned. Level and grout equipment where necessary. Support conduit independently of equipment and so as not to cause a strain or thrust.

4. Determine exact location of all equipment, foundations, and supports after Shop Drawings of equipment have been approved.

F. Installing Outdoor Equipment Foundations:

1. Provide equipment foundations of size and thickness as indicated.

2. Place reinforcement accurately in position shown, securely fasten and support to prevent displacement before or during pouring. Clean, bend, place, and splice reinforcement in accordance with approved shop drawings. Lap ends and sides of mesh reinforcement in slabs not less than one inch. Coverage of main reinforcing shall be as follows:

a. Slabs - 3/4 inch

b. Concrete poured against earth - 3 inches

c. Other locations - 2 inches

3. Properly align, level, and grout all equipment where necessary.

3.4 QUIET OPERATION AND VIBRATION

A. All equipment and/or systems shall operate under all conditions of load without any sound or vibration being greater than the anticipated dBA sound level for the space or

surrounding areas. Humming, vibrating, and/or moving machinery, sound, or vibration shall be low enough in level that it does not interfere with the occupancy requirements of the space being served. Vibration control shall be by means of approved vibration eliminators in a manner as recommended by the manufacturer of the equipment. Sound and vibration measurements shall be taken of all equipment and spaces at no cost to the project and sound or vibration conditions considered objectionable by the Owner's Representative shall be corrected in an approved manner at no expense to the Owner.

3.5 PROVISIONS FOR ACCESS:

A. Provide access panels and doors for all concealed equipment, splice boxes, junction boxes, remote ballasts, disconnects, motor starters, control devices, and other devices requiring maintenance, service, adjustment, manual operation, or as otherwise required by Code.

B. Where access doors are necessary, furnish and install manufactured steel door assemblies consisting of hinged door, key locks (keyed alike), and frame designed for the particular wall or ceiling construction. Access doors shall be set in frames with countersunk screws and shall have cylinder locks. All locks shall have one Master Key. Properly locate each door. Door size shall be a minimum of 24-inch x 24-inch. Provide UL approved and labeled access doors where installed in fire rated walls or ceilings. Doors shall be Milcor Metal Access Doors as manufactured by Inland-Ryerson, or approved equal.

1. Acoustical or Cement Plaster: Style B

2. Hard Finish Plaster: Style K or L

3. Masonry, Ceramic Tile, or Dry Wall: Style M (Stainless Steel).

4. Fire-rated where occurring in fire-rated walls.

C Where access is by means of lift-out ceiling tiles or panels, mark each panel using small color-coded or numbered tabs. Provide a chart or index for identification. Provide chart in O&M Manual. Screw markers on ceiling grid.

D. Access panels, doors, etc. described herein shall be furnished under the section of specifications providing the particular service to be turned over to the pertinent trade for installation. Coordinate installation with all trades.

E. Electrical equipment shall be installed so that working clearances in front of the electrical equipment which is likely to require examination, adjustment, servicing, or maintenance while energized, shall be as required by the NEC.

F. In occupied spaces, provide finished access units of the maximum concealment type, including locks where appropriate, and matching other access units provided in the same expanse of finish (for non-electrical access, if any).

G. Scope: The scope of access units to be furnished or provided as electrical work includes those units indicated on the electrical drawings or specified in Division 26 sections, and those additional units required for adequate access to electrical work and not shown or specified individually.

H. Access Doors: Standard welded steel Construction, 16 gauge frames and 14 gauge door

panels, 175-degree concealed spring hinges, rust-inhibitive prime coat, flush cam lock (for screw-driver operation where keyed lock is not required), recessed to receive applied finish where applicable, 5-pin/disk tumbler lock where indicated.

I. Removable Access Plates: Where only hand access is sufficient, provide removable plate-type access unit, of minimum size which will facilitate the required access. Provide units of the type, style, design, material and finish appropriate for the location and exposure in each instance. In exposed surfaces of occupied spaces, provide round plate units, flush floor units, and frameless low-profile wall units, primed for paint where installed in painted surfaces and polished chrome or stainless steel finish in other surfaces.

J. Provide access doors in walls and inaccessible ceilings for concealed electrical equipment and all other concealed electrical specialties and appliances that require manual operation or maintenance.

K. Submit shop drawings indicating the proposed location of all access panels/doors. Access doors in finished spaces shall be coordinated with air devices, lighting and sprinklers to provide a neat and symmetrical appearance.

3.6 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work, including the following:

1. Raceways.

2. Building wire and connectors.

3. Supporting devices for electrical components.

4. Electrical identification.

5. Concrete bases.

6. Electrical demolition.

7. Cutting and patching for electrical construction.

8. Touchup painting.

3.7 REFINISHING AND TOUCHUP PAINTING

A. Provide protective finishes on all materials and equipment. Use coated or corrosion-resistant materials, hardware and fittings throughout the work. Paint bare, untreated ferrous surfaces with rust-inhibiting paint. All exterior components including supports, hangers, nuts, bolts, washers, vibration isolators, etc., shall be galvanized or stainless steel.

B. Clean surfaces prior to application of coatings, paint, or other finishes.

C. Provide factory-applied finishes where specified. Unless otherwise indicated factory-applied paints shall be baked enamel with proper pre-treatment.

D. Protect all finishes and restore any finishes damaged as a result of work under Division 26 to their original condition.

E. The preceding requirements apply to all work, whether exposed or concealed.

F. Remove all construction marking and writing from exposed equipment, conduit, and building surfaces. Do not paint manufacturer's labels or tags.

G. All exposed conduit, etc. in public spaces shall be painted. Colors shall be selected by the Architect and conform to ANSI Standards.

3.8 CLEANING AND PROTECTION

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

C. Replace all damaged ceiling tiles.

D. Clean all ceiling tiles soiled during construction. Marks, fingerprints, and other soiling of the ceiling tiles shall be cleaned.

END OF SECTION 260501

SECTION 260502 - ELECTRICAL DEMOLITION FOR REMODELING

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 SCOPE

A. Provide all demolition of existing electrical circuits including all conduit and wiring as required by the Contract Documents. Electrical demolition shall be performed in accordance with the Contract Documents or as directed by the General Contractor.

B. Provide all cutting and patching for electrical construction.

C. Provide temporary service and provisions to maintain existing systems.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work: As specified in individual Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that field measurements and circuiting arrangements are as shown on the Drawings.

B. Verify that abandoned wiring and equipment serve only abandoned facilities.

C. Verify whether or not PCB ballasts exist in light fixtures which will be disposed of. If PCB light fixture ballasts exist, then follow requirements in "PCB Ballast Handling and Disposal", included in this Section.

D. Demolition Drawings are based on casual field observation and existing record documents. Report discrepancies to the Owner, Architect and Engineer before disturbing existing installation.

E. Beginning of demolition means installer accepts existing conditions.

3.2 PREPARATION

A. Disconnect and make electrically safe electrical systems in walls, floors, and ceilings

scheduled for removal.

B. Coordinate utility service outages and removal with the Owner, Architect, and Engineer and other trades. Also, coordinate utility service outages and removal with Utility Company.

3.3 CONNECTIONS AND ALTERATIONS TO EXISTING SYSTEMS

A. Keep all existing electrical systems in operation during the progress of the work. Provide temporary electrical connections to systems of equipment, etc., where necessary to maintain continuous operation until the new systems and equipment are ready for operation.

B. When existing electrical work is removed, remove all conduit, ducts, supports, etc. to a point below the finished floors or behind remaining finished walls and cap. Such points shall be far enough behind finished surfaces to allow for the installation of the normal thickness of finished material unless directed otherwise.

C. When the work specified hereunder connects to any existing equipment, conduit, wiring, etc., perform all necessary alterations, cuttings, fittings, etc., of the existing work as may be necessary or required to make satisfactory connections between the new and existing work and leave the complete work in a finished and workmanlike condition.

D. When the work specified under other divisions necessitates relocation of existing equipment, conduits, wiring, etc., perform all work and make all necessary changes to existing work as may be required to leave the completed work in a finished and workmanlike condition.

E. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations. In particular, all security and safety systems must be maintained in operation at all times as required by the Owner. This includes security and safety lighting.

F. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from Owner, Architect/Engineer and other trades at the site at least 24 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

G. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Notify Owner, Architect and Engineer and local fire service at least 24 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

H. As directed by the General Contractor: Maintain existing system in service until new system is complete and ready for service/new system is accepted/ or until Disable system only to make switchovers and connections. Obtain permission from/Notify the Owner/Architect/Engineer and at least 24 hours before partially or completely disabling

system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

I. Trace all circuits and controls to be disconnected to ensure that vital services to other areas are not interrupted.

3.4 PROTECTION

A. Provide protection for all existing and new cabling. Provide inner duct, conduit or other suitable means of protection to prevent damage to cables located in renovated areas.

B. Damage to wiring, cabling or equipment shall be repaired by skilled mechanics for the trade involved at no additional contract amount.

C. Fixtures, materials and equipment shall be protected at all times. The Contractor shall make good any damage caused either directly or indirectly by his workmen. Conduit openings shall be closed with caps or plugs during installation. Fixtures and equipment shall be tightly covered and protected against dirt, water and chemical or other injury. At the completion of all work, the fixtures, materials and equipment shall be thoroughly cleaned and turned over in a condition satisfactory to the Owner.

D. Damage: Where wiring, raceways, lighting fixtures, devices or equipment to remain is inadvertently damaged or disturbed, cut out and remove damaged section and provide new of equal or capacity or quality.

3.5 ELECTRICAL DEMOLITION

A. Remove from the premises and dispose of all existing wiring, conduit, material, fixtures, devices, equipment, etc., not required for re-use or re-installation.

B. Deliver on the premises where directed existing material and equipment which is removed and is desired by the Owner or is indicated to remain the property of the Owner.

C. Equipment and materials which are removed shall become the property of the demolisher and shall be removed by him from the premises.

D. Where electrical equipment is removed, also remove all wiring back to source panelboard or switch or to last remaining device on the same circuit. All conduit, hangers, supports, etc., shall also be removed unless otherwise noted. Such conduit may remain to be reused for new work provided said conduit is of the proper size and type as that specified and in a condition acceptable to Engineer and Owner.

E. Any conduit abandoned in concrete slabs, walls, or other inaccessible locations shall be left empty except for a nylon pull wire. Ends shall be capped with push plugs for future use.

3.6 EXISTING CONDUIT WORK

A. Remove exposed abandoned raceway, including abandoned raceway above accessible ceiling finishes. Cut raceway flush with walls and floors, and patch surfaces.

B. Remove concealed abandoned raceway to its source.

C. Abandoned Work: buried electrical work abandoned in place, shall be cut out approximately 2 inches beyond the face of adjacent construction, capped and the adjacent surface patched to match the existing finish.

D. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if raceway servicing them is abandoned and removed.

E. Extend existing raceway and box installations using materials and methods compatible with existing electrical installations, or as specified.

F. Remove all abandoned wiring from existing conduits and ductbanks.

G. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors and patch surfaces.

3.7 EXISTING WIRING AND CABLING WORK

A. Remove exposed wire and cable, including abandoned wire and cable above accessible ceiling finishes. Patch surfaces where removed cables pass through building finishes.

B. Disconnect circuits and remove circuit wire and cable. Remove abandoned boxes if wire and cable servicing them is abandoned and removed.

3.8 EXISTING WIRING DEVICES WORK

A. Disconnect wiring devices and remove them.

B. Provide painted blank coverplates over existing device boxes. Paint shall match existing finish of surrounding area.

C. Disconnect outlets and remove devices. Remove abandoned outlet boxes if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlet boxes which are not removed.

3.9 EXISTING FUSE WORK

A. Remove fuses from circuits.

3.10 EXISTING TRANSFORMER WORK

A. Disconnect and remove transformers.

3.11 EXISTING DISTRIBUTION WORK

A. Disconnect and remove panelboards and distribution equipment.

B. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

3.12 DEMOLITION AND EXTENSION ENSION OF EXISTING ELECTRICAL WORK

A. Demolish and extend existing electrical work to meet all requirements of these specifications.

B. If certain raceways and boxes are abandoned but not scheduled for removal, those items must be shown on the As-Built Drawings.

C. Remove, relocate, and extend existing installations to accommodate new construction.

D. Remove existing wiring to source of supply.

E. Disconnect and remove existing luminaires. Remove brackets, stems, hangers, and other accessories.

F. Repair adjacent construction and finishes damaged during demolition and extension work.

G. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.

H. Extend existing installations using materials and methods (compatible with existing electrical installations, or) as specified. This includes the extension of the circuit from the last active device to the next device in the system to be activated.

3.13 LAMP HANDLING AND DISPOSAL

A. Is the responsibility of the Contractor to properly handle and dispose of all contaminated lamps. All lamps (fluorescent, incandescent, and HID) contain mercury and/or lead (in the base) as well as other heavy metals and compounds which are regulated by the EPA and DNR during the disposal process. As a result, regulations have been issued covering the handling and disposal of all lamps. Therefore, lamps which have been removed from service for disposal shall be handled as follows.

1. Very carefully remove all lamps (fluorescent, incandescent and HID) from light fixtures before removal of the fixture from its mounted position. This is to reduce the likelihood that the lamp(s) will be broken.

2. Removed lamps shall be placed in containers and placed in storage in a location on the Owner's property (this may be in another building) arranged by the Owner's field representative. Label the area as *Hazardous Material Storage — Mercury.*

3. Provide to the Owner's field representative, in written form, a count of all stored lamps by type at the completion of the project.

4. The Contractor will have the responsibility to dispose of all contaminated lamps as required by EPA and DNR Rules and Regulations.

5. Provide to the Owner's Representative copies of all documents including

manifests, certificates, etc. that show the handling, transportation, delivery and disposal of stored lamp materials identified above.

3.14 PCB BALLAST HANDLING AND DISPOSAL

A. It is the Contractors responsible to properly handle and dispose of contaminated ballasts. Generally, all high power factor fluorescent light ballasts manufactured before 1978 and some HID ballasts contain PCB compounds in their capacitors. The Contractor shall inspect all ballasts in light fixtures (which will become the property of the Contractor and will be removed from the project site as part of this project). The handling, removal and disposal of all PCB contaminated ballasts shall be the Contractors responsibility. The Contractor shall take the actions described below.

1. All ballasts labeled as NON PCBs or NO PCBs shall become the property of the Contractor. If the PCB content is *not* stated on the ballast label, the ballast shall be handled as a PCB ballast.

2. All PCB ballasts shall be removed from the light fixtures and shall have the wires clipped off. However, before removal, all PCB ballasts shall be carefully inspected for leaks. <u>If a ballast appears to be leaking (evidenced by potting compound leaking out or by an oily film on the ballast surface) the ballast must be handled per EPA and DNR PCB regulations).</u> Basically, this means the ballast is to be carefully removed from the fixture and placed in an approved drum. The person removing the ballast from the fixture shall wear protective gloves, eye protection, and protective clothing as necessary.

3. If the fixture has also been contaminated, it must be cleaned to less than 10 micrograms/100 square centimeters contamination before disposal. This cleaning must be done by an approved PCB Contractor and is not considered a part of this contract.

4. The ballasts shall then be placed in US DOT approved Type 17C or Type 17H drums (barrels). Fifty-five gallon and 30 gallon drums are available from most drum suppliers. The quantity and size of the drums will be determined at the time of construction.

5. These barrels shall be placed in storage with the cover that came with the barrels, in a location within a building, as designated by the Owner's project representative. The barrels are *not* to be placed outside where they are exposed to weather.

6. THESE BALLASTS ARE NOT TO BE REMOVED FROM THE WORK SITE. To do so, would be a violation of DNR and DOT hazardous waste regulations and may result in a fine.

7. Label and mark the PCB storage drums with EPA-approved PCB labels and the storage area with signs, marks, and lines to meet the regulations of Code.

8. Provide approved PCB-absorbent materials to be stored immediately adjacent to the drum storage area. Do not place loose absorbent material in the drums.

9. Provide to the Owner's project representative, in written form, a total count of these ballasts (or their total weight by barrel) and where they are stored.

10. The Contractor will have the responsibility to dispose of all contaminated ballasts as required by EPA and DNR Rules and Regulations.

11. Provide to the Owner's Representative copies of all documents including manifests, certificates, etc. that show the handling, transportation, delivery and disposal of stored ballast materials identified above.

3.15 INSTALLATION

A. Install relocated materials and equipment under the provisions of other related Sections.

END OF SECTION 260502

SECTION 260510 - ELEVATOR EQUIPMENT WIRING AND PROVISIONS

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 WORK INCLUDED

A. Power wiring and devices to elevator drive equipment.

B. Power wiring and devices for elevator cab equipment.

C. Additional miscellaneous service connections may include:

1. Telephone service connection.
2. Public address system connection.
3. Emergency power system connections.
4. Elevator lobby smoke detector connections.
5. Safety light and outlet in elevator pit.

D. Elevator control wiring and interlock controls not included.

E. All electrical work specified to be done *by others* in Division 24.

1.3 COORDINATION

A. Coordinate with elevator contractor, elevator inspector, electrical inspector, and fire marshal prior to installation.

B. Prepare coordination drawings and sketches as needed to provide complete information.

C. Coordinate with other trades to avoid foreign equipment, not dedicated to serving Elevator Machine Room, from being installed in Elevator Machine Room.

D. Coordinate entire installation with elevator system installer prior to rough-in and prior to installation of equipment.

E. Coordinate location of lights, machines, and equipment installed in elevator pit and machine rooms with elevator system installed on site prior to installation.

1.4 REGULATIONS

A. Comply with NEC.

B. Comply with NFPA: NFPA 101 Life Safety Code.

C. Comply with ANSI/ASTM Elevator Code.

D. Comply with International Building Code.

PART 2- PRODUCTS

2.1 ELECTRICAL PROVISIONS

A. Provide lockable heavy duty type fused switches in circuits for elevator cab power (lighting/ventilation), for elevator drive, and if required for signal power. Provide fuses sized as directed by elevator supplier. Provide in accordance with NEC Articles 620-22 (a), 62053, and 620-85.1. Disconnect shall be lockable in the OPEN position and the closed position. Provide each disconnect with a sign to identify the location of the supply side overcurrent protection device.

B. Provide fused disconnect switch adjacent to elevator equipment room door. Locate on strike side of door. Provide one disconnect for each elevator controller unit.

C. Provide all power wiring from source through disconnect to elevator controller to motor.

D. Provide manual starter labeled *LIGHTS* adjacent to power disconnect. Extend 120 volt circuit from source through manual starter to controller. Provide one manual starter and 120 volt circuit per unit.

E. Provide $^{3}/4$-inch conduit, with two (2) Category 6E cable[s] from each elevator controller to nearest telephone wiring closet.

F. Provide lock-clip devices on each circuit breaker serving elevator car and room, both lighting and power circuits.

G. Provide shunt trip circuit breaker serving each elevator controller. Connect to heat detectors as required. Provide power to shunt trip unit as required. Size per elevator supplier directions.

H. Provide all wiring for and mount exterior alarm bell. Feed from emergency source.

I. Provide compact fluorescent lighting fixture with porcelain lamp holder, 60-watt lamp with lamp guard and duplex GFCI receptacle 72-inches above elevator pit. Provide switch adjacent to access ladder near the hoistway door, 36-inch above door sill. Provide switch, receptacle, lamp, lamp holder, and lamp guard lighting fixture on every other floor above the lowest level for each elevator. Provide in accordance with NEC Articles 620-24 and 620-85.

J. All traveling cables, control stations, control station wiring and final control connections at the controller shall be furnished and installed under Division 24**.**

K. Provide elevator machine room lighting and receptacles in accordance with NEC Articles 620-23 and 620-85. Locate lights in room to provide optimum illumination for all machinery, and the front and rear of each controller. Provide light switch by the machine room entrance.

L. Provide for elevator car a separate dedicated 120 volt, 20 ampere branch circuit with a lockable disconnect switch in the elevator machine room, with two #12 and one #12 ground, in 3/4-inch conduit to elevator controller, to serve car lighting, ventilation and car top receptacle. Label disconnect switch *"cab lights"*.

2.2 FIRE ALARM PROVISIONS

A. Provide smoke detector in each elevator equipment room or space. Connect main alarm contacts to fire alarm system and auxiliary contacts to the controller per BOCA 2611.4 and ANSI/ASME A17.A. Provide remote indicating lamp unit at door.

B. Provide heat detectors within 24-inches of each fire protection sprinkler head in the elevator shaft and elevator machine room. Connect heat detectors to shunt trip breaker serving elevator.

C. Provide fire return/recall smoke detector in each elevator lobby within five (5) feet of elevator entrance. Connect main alarm contacts of fire alarm system and auxiliary contacts to elevator controller. Provide two #18 AWG in 3/4-inch conduit to elevator terminals as directed by Elevator Contractor.

D. Provide fire alarm control modules and monitoring modules as required per Specifications and codes.

E. Provide 2 #18 wiring in 3/4-inch conduit from each elevator lobby smoke detector to each elevator controller in the Elevator Machine Room.

F. Provide dedicated fire alarm system valve tamper switch and water flow switch at the following locations:

1. At the top of each elevator shaft.

2. In each elevator pit.

3. In each Elevator Machine Room.

G. Provide smoke detectors at the top of each elevator shaft. Provide remote indicating lamp unit at top floor elevator lobby and connect to smoke detector.

2.3 EMERGENCY POWER PROVISIONS

A. Provide control wiring from emergency power system automatic transfer switch to auxiliary contact to elevator drive control panel to signal that transfer from normal to

emergency power has occurred. Verify auxiliary contact arrangement required by elevator manufacturer.

B. Feed elevator cab lights from emergency power source.

C. Feed elevator lowering control power from emergency power source.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Locate all disconnect devices and elevator machine room light switch on lock side of door within elevator machine room. Devices are typically located within 1'-6” of entrance.

END OF SECTION 260510

SECTION 260513 – MEDIUM VOLTAGE CABLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. The extent of medium voltage cable Work is indicated by Drawings and by the requirements of this Section.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within all following references.

1.04 QUALITY ASSURANCE

A. Installer shall be a firm with at least five (5) years of successful installation experience on projects with electrical work similar to that required for this Project.

B. NEC Compliance: Comply with the National Electrical Code (NFPA 70) as applicable to construction and installation of electrical cable, and terminations required for this Project.

1.05 SUBMITTALS

A. Product Data:

1. Submit manufacturer's data on electrical cable and terminations.

B. Record Documents:

1. Submit a list of previous work evidencing at least five (5) years experience in medium voltage cable installation of similar type.

2. Submit name and experience record of each person to be engaged in medium voltage cable work. Only those persons accepted by the Owner will be permitted to engage in medium voltage cable work.

3. Submit three (3) copies of cable manufacturers' certified test report prior to installation of cable.

4. Submit certified field test report.

1.06 DELIVERY, STORAGE AND HANDLING

A. Provide factory wrapped waterproof flexible barrier materials for covering cable on wooden reels.

B. Store cable in factory finished covering and in clean, dry place which provides protection against weather.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 MANUFACTURERS

A. All 5 kV conductors shall be by only one of the following manufacturers:

1. Okonite.

2. Rome.

2.03 5 KV INSULATED CONDUCTORS

A. Size: As shown.

B. Single Conductor Construction:

1. Single uncoated annealed copper conductor with Class B stranding.

2. Extruded semi-conducting thermosetting conductor screen firmly bonded to the overlaying insulation.

3. Ethylene-propylene-rubber (EPR) insulation 90 mils thick.

4. Extruded semi-conducting thermosetting insulation screen.

5. Copper shielding tape 5 mils thick, helically applied with a minimum 25 percent overlap.

6. Polyvinyl chloride jacket with thickness per ICEA.

7. The conductor screen, insulation and insulation screen shall be applied in triple tandem extrusion and simultaneously vulcanized.

C. Medium voltage terminations shall be equal to 3M 5630K series, Class 1, 5-35 kV, cold-shrink rubber termination kits.

D. Electrical tapes shall be equal to those manufactured by Electroproducts Division/3M as follows:

1. Fireproofing: Scotch No. 77.

2. Glass Cloth: Scotch No. 60.

3. Self-fusing Silicone Rubber: Scotch No. 70.

4. Vinyl Plastic: Scotch No. 88.

PART 3 - EXECUTION

3.01 PREPARATION

A. Examine areas and conditions under which medium voltage cable terminations are to be installed and notify the Owner in writing of conditions detrimental to the proper and timely completion of the Work.

B. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Install medium voltage cable and terminations as indicated in accordance with the manufacturer's written instructions, the applicable requirements of NEC, and in accordance with recognized industry practices to ensure that products serve the intended functions.

D. Medium Voltage Cable Identification:

1. Identify cables as to phase and circuit at each accessible location. Identification to be accomplished by means of brass tags embossed in letters no less than ½ inch high, permanently affixed to each current carrying cable.

2. Arrange tags such that they can be read without moving cables.

E. Where cable terminates in a stress cone, wrap exposed insulation with half-lapped layer of self-fusing silicone tape applied without stretch. Secure ends of silicone tape with vinyl plastic tape to prevent ravel.

F. Damaged cable jacket and/or insulation will be cause for rejection of cable. Do not install cable if jacket is damaged in any way. No kinks are permitted and the bends are to be kept in accordance with the minimums recommended by the manufacturer. Pull cables directly into the duct from the coil or reel on which they are received. Cable shall not be pulled off and laid on the ground prior to installation. Make pulls in one direction.

G. Splices are not permitted for new pulls. Contractor shall pull all cables in continuous lengths. Splices are permitted only where indicated on the Drawings for connections to existing underground medium voltage feeders in manholes. The installer shall be a trained and certified technician for such special installation with appropriate splicing kit and materials recommended by cable manufacturer.

H. Provide cable lengths with liberal allowances for slack for terminating. If pulling grips are used, sufficient excess cable shall be allowed so that damage due to the pulling grips can be removed prior to terminating. Use rubber tape to seal cable ends. Cable shall not be pulled with the ends open. Cable ends shall not be allowed to rest on the floor. Cable ends shall be moisture proofed at all times until terminations are installed.

I. Provide pull-in guides, cable feeders or draw-in protectors to prevent damage to the cable at the duct mouths. Pull cable by grips on the conductors with proper taping to prevent pushback. Short lengths may be pulled with cable grips around the entire group; however, care should be taken to ensure equal distribution of tension and any damaged ends must be cut off and discarded before terminating the cable.

J. Stop pulling instantly if undue tension occurs. Lubricant shall be used to facilitate pulling and shall be compatible with the type of cable used.

K. Identify individual phases of each power circuit at points near each end of the cables. Before connections are made at cable terminals, check by ringing out or talking over each conductor by means of a portable hand telephone set. Identify circuits before terminal connections are made by one of the methods specified above.

3.03 PRIMARY CABLE TESTING

A. The cable manufacturer shall perform non-destructive factory tests on all cable in accordance with ICEA standards and shall furnish three (3) copies of certified test reports to the Owner.

B. Cables shall be field-tested prior to energization. Notify the Owner at the proper time during construction that the cables are ready for field-testing. Cables shall not be energized prior to testing.

C. The Contractor shall select an Owner-approved cable-testing agency and will pay for the initial set of tests.

D. The Contractor shall contact an approved accredited cable-testing agency and will have cables, stress cones, and potheads tested (per ICEA Standards) at the proper time during construction. Any cable, stress cone or pothead showing any form of failure under the test or showing a fault shall be replaced at no additional cost to the Owner and shall be retested by the same testing agency at the Contractor's expense.

E. Each circuit shall be rung-out or talked-out with proper signaling devices and with all equipment disconnected at each end to indicate that it is a continuous circuit where the operating requirements are that it shall be continuous.

F. Insulation resistance of each cable shall be measured with a 500-volt megohm meter. Cable will be rejected if resistance is less than 25 megohms.

G. All power cables shall be given D.C. high potential tests after potheads or other terminations have been made, but before connections have been made to busses or apparatus according to the manufacturer's recommendation and ICEA standards. A non-destructive D.C. testing device, such as Von, Westinghouse "High Pot Tested" or accepted substitution, shall be employed.

1. A D.C. microammeter in series with the ground connection of the high voltage transformer shall be used to read the leakage current in the cable at intervals specified hereinafter. A variable ratio voltage regulator of adequate rating shall be used to permit the raising of test voltage at a slow but uniform rate from zero to test value. Testing time shall be started when the voltage on the cable has attained test value.

2. Each cable shall be tested for a minimum of fifteen (15) minutes or until the current reading levels off and remains steady for at least three minutes. The potential shall be raised at a slow uniform rate with current readings taken every fifteen seconds until full voltage is reached; thereafter, current readings shall be recorded separately. The removal of the voltage shall be done in an approved manner to prevent damaging the cable.

3. The test voltage shall be in accordance with ICEA recommended values as follows:

ircuit Voltage (Phase-to-Phase Volts)	t Voltage (133% Insulation Level)
5000	
15000	

H. Adequate means shall be taken to ensure safety during the tests and all safety instructions of the test operator shall be carried out.

I. If a cable fails, the fault shall be located, and all cables in the conduit between the nearest pulling points on each side of the failure shall be withdrawn. If, in the opinion of the Owner, the other cables in the same conduit have not been damaged, they may be reinstated, but the cable that failed shall be replaced by new cable. After the replacement of the faulted cable, and any other damaged cables, all cables of the circuit in that conduit shall be retested.

J. During the Warranty Period, any failure in primary cable, terminations or splices shall require immediate correction. In the event of a failure creating interruption in electrical service, furnish and install all labor and materials for temporary services to get the electrical system back in service. Work shall begin immediately upon notification of a failure, regardless of time.

END OF SECTION 260513

SECTION 260519 - CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.3 SUBMITTALS

A. Field Test Reports: Indicate and interpret test results for compliance with performance requirements. Indicate procedures and values obtained.

B. Submit Product Data: Provide for each cable assembly type, wire, cables, conductors, and connectors.

C. Submit factory test reports. Indicate procedures and values obtained.

D. Submit shop drawings for modular wiring system including layout of distribution devices, branch circuit conduit and cables, circuiting arrangement, and outlet devices.

E. Submit manufacturer's installation instructions. Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.

F. Project Record Documents: Record actual locations of components and circuits.

1.4 QUALITY ASSURANCE

A. Listing and Labeling: Provide wires and cables specified in this Section that are listed and labeled.

1. The Terms *Listed and Labeled:* As defined in NFPA 70, Article 100.

2. Listing and Labeling Agency Qualifications: A *Nationally Recognized Testing Laboratory* as defined in OSHA Regulation 1910.7.

B. Comply with NEMA/Insulated Cable Engineers Association (ICEA) Standards.

C. Comply with NECA Standard of Installation.

D. Comply with NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

E. American Society for Testing and Materials (ASTM): Comply with requirements of the following:

1. Bl: Standard Specification for Hard-Drawn Copper Wire

2. B2: Standard Specification for Medium-Hard-Drawn Copper Wire

3. B3: Standard Specification for Soft or Annealed Copper Wire

4. B8: Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

5. D753: Standard Specification for General Purpose Polychloroprene Jacket for Wire and Cable

F. Electrical Testing Laboratories (ETL): Provide wiring, cabling and connector products which are ETL listed and labeled.

G. Institute of Electrical and Electronics Engineers (IEEE): Comply with the following standards which apply to wiring systems:

1. 82: Test procedure for Impulse Voltage Tests on Insulated Conductors

2. 241: Recommended Practice for Electric Power Systems in Commercial Buildings

H. NFPA: Comply with NFPA 70 requirements for construction, installation and color coding of electrical wire, cable and connections.

I. National Electrical Manufacturer's Association (NEMA): Comply with requirements of the following:

1. WC3: Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

2. WC5: Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

J. UL: Provide material conforming to the following standards:

1. UL 83 - Thermoplastic-Insulated Wires and Cables.

2. UL 486A - Wire Connectors and Soldering Lugs for Use with Copper Conductors.

3. UL 854 - Service-Entrance Cables.

K. UL Labels: Provide wiring, cabling and connector products which are UL listed and labeled.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver wires and cables according to NEMA WC 26, *Wire and Cable Packaging*.

B. Storage: Store wire and cable in a clean dry space in original containers. Protect products from weather, damaging fumes, construction debris and traffic.

C. Handling: Handle wire and cable carefully to avoid abrading, puncturing and tearing wire and cable insulation and sheathing. Ensure that dielectric resistance integrity of wires/cables is maintained.

1.6 COORDINATION

A. Contractor to furnish and install all labor and material for the installation of the conduits, raceways, outlet boxes, backboxes, and sleeves for the communication systems.

B. Coordinate conduit raceways, outlet boxes, backboxes, and sleeves with the Communication Contractor.

C. Install direct burial fiber cable, telephone cable and outside plant cable in conduit/ductbanks.

These cables will be provided by an Electrical Contractor. Refer to Specification 271000.

D. Coordinate layout and installation of cables with other installations.

E. Revise locations and elevations from those indicated, as required to suit field conditions and as approved by Engineer.

F. Determine required separation between cables and other work.

G. Determine cable routing to avoid interference with other work.

1.7 PROJECT CONDITIONS

A. Verify that field measurements are as shown on the Drawings.

B. Conductor sizes are based on copper.

C. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet Project Conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Wires and Cables:

    a. Simpull (shall have impregnated colored insulation)

    b. American Insulated Wire Corp.; Leviton Manufacturing Co.

    c. BICC Brand-Rex Company.

    d. Carol Cable Co., Inc.

    e. Senator Wire & Cable Company.

    f. Southwire Company.

    g. Colonial Wire Company

2. Connectors and Accessories for Wires and Cables:

    a. AMP Incorporated.

    b. Buchanan.

    c. General Signal; O-Z/Gedney Unit.

    d. Monogram Company; AFC.

    e. NSI Industries, Inc.

    f. Square D Company; Anderson.

    g. 3M Company; Electrical Products Division.

2.2 BUILDING WIRES AND CABLES

A. UL-listed building wires and cables with conductor material, insulation type, cable construction, and rating as specified in Part 3 Article *"Wire and Insulation Applications"*.

B. Rubber Insulation Material: Comply with NEMA WC 3.

C. Thermoplastic Insulation Material: Comply with NEMA WC 5.

D. Cross-Linked Polyethylene Insulation Material: Comply with NEMA WC 7.

E. Ethylene Propylene Rubber Insulation Material: Comply with NEMA WC 8.

F. Conductor Material: Copper.

G. Stranding: Solid conductor for No. 10 AWG and smaller; stranded conductor for larger than No. 10 AWG. All conductors shall be stranded.

H. Conductor: Single conductor annealed copper type.

I. Insulation Voltage Rating: 600 Volts.

J. Conductivity: Minimum of 98 percent at 20 degrees C (68 degrees F) or maximum resistivity of 1.7 micro-ohms per centimeter.

2.3 CONNECTORS AND SPLICES

A. UL-listed, factory-fabricated wiring connectors of size, ampacity rating, material, type, and class for application and service indicated. Comply with Project's installation requirements and as specified in Part 3 Article, *"Wire and Insulation Applications"*.

B. Split Bolt Connectors: [Not acceptable.] [Blackburn Type H Model] [Blackburn Type HPS Model].

C. Push-in wire connectors: Not acceptable.

D. Solderless Pressure Connectors: High copper alloy terminal. May be used only for cable termination to equipment pads or terminals. Not approved for splicing.

E. Spring Wire Connectors: Solderless spring type pressure connector with insulating covers for copper wire splices and taps. Use for conductor sizes 10 AWG and smaller.

F. All wire connectors used in underground or exterior pull boxes shall be gel-filled twist connectors or a connector designed for damp and wet locations.

G. Mechanical Connectors: Bolted type tin-plated; high conductivity copper alloy; spacer between conductors; beveled cable entrances.

H. Compression (crimp) Connectors: Long barrel; seamless, tin-plated electrolytic high conductivity copper tubing, internally beveled barrel ends. Connector shall be clearly marked with the wire size and type and proper number and location of crimps.

I. Heat shrinkable tubing shall meet the requirements of ANSI C119.1-1986 for buried connections to 90 degrees C and shall be material flame-retarded per IEEE 383 *Vertical Tray Flame Test.*

J. Motor connection kits shall consist of heat-shrinkable, polymeric insulating material over the connection area and a high dielectric strength mastic to seal the ends against ingress of moisture and contamination. Motor connection kits shall accommodate a range of cable sizes for both in-line and stub-type configurations. Connection kits shall be independent of cable manufacturer's tolerances.

K. Wire Nut Connectors:

1. Wire nuts installed in wet locations, exterior, etc., shall be self-contained, waterproof and corrosion-proof units incorporating prefilled silicone grease to block out moisture and air.

2. Connectors shall be UL listed and appropriately sized according to manufacturer's recommendation for the suitable wire sizes and voltage rating (600 volt minimum).

3. Connector body shall have a color-coded outer shell.

4. Connectors shall be as manufactured by Ideal, 3M, or approved equal.

2.4 INSULATING TAPE, PUTTY, RESIN AND SUPPORTS

A. Tape: Provide plastic electrical insulating tape which is flame-retardant, cold and weather-resistant. Tape for use in areas subject to temperatures 30 degrees C to 105 degrees C, or where the tape will be subjected to an oil splash, tape shall have a minimum thickness of 8.5 mils, and shall consist of an oil-resistant acrylic adhesive.

B. Materials: Provide all insulating materials for splices and connections such as glass and synthetic tapes, putties, resins, splice cases, or compositions of the type approved for the particular use, location, voltage and temperature and apply and install in an approved manner, all in accordance with the manufacturer's recommendations.

C. Supports: Provide cable supports of the wedge type which firmly clamp each individual cable and tighten due to the cable weight.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine raceways and building finishes to receive wires and cables for compliance with requirements for installation tolerances and other conditions affecting performance of wires and cables. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. By beginning work, the Contractor has accepted conditions and assumes responsibility for correcting unsuitable conditions encountered at no additional cost to the Owner.

3.2 PREPARATION

A. Completely and thoroughly swab raceway before installing wire.

3.3 WIRE AND INSULATION APPLICATIONS

A. Building wire, unless otherwise indicated shall be 600 volt, Type THWN or THHN for #8 AWG wire and smaller, and Type THWN or THW for #6 AWG wire and larger for interior use, and Type THWN or THW insulation for underground or exterior installations outside building installation. Conductors shall be sized and run as indicated. Conductors shall be soft drawn copper of not less than 98 percent conductivity.

B. No branch circuit wires smaller than #12 AWG shall be used unless otherwise indicated. Conductors shall be continuous from outlet to outlet and from terminal board to point of

final connection, and no splice shall be made except within outlet or junction boxes. All conductors shall be of the size indicated. All wires #8 AWG and larger shall be stranded.

C. Control wiring shall not be less than #14 AWG and shall be color coded using colors impregnated into the insulation. All wiring, contacts, and terminal blocks shall be suitably tagged for ease in identification and tracing of circuits. Identification tags shall be engraved fiber or plastic type, subject to acceptance. Wires shall be numbered and coded, using Brady *Quicklabels,* or equal.

D. A color coding system, as listed below, shall be used throughout the building's network of feeders and circuits and used as a basis of balancing the load. The following color coding shall be used unless an existing system has used a different color code. If this situation occurs obtain approvals prior to installation. Selection shall be based on applicable work covered by this Contract.

System	Color				
	Phase A	Phase B	Phase C	Neutral	Ground
208Y/120V	Black	Red	Blue	White	Green
480/277V	Brown	Orange	Yellow	Gray	Green

1. All wiring sizes #12 AWG up to 500 KCMIL shall have Simpull impregnated colored insulation, using color chart above.

2. All emergency wiring shall have the same color coding but shall clearly be identified as emergency in all outlets, fixtures, etc. All emergency wiring shall be installed in a dedicated conduit system.

3. Switch leg wire shall be labeled with *"S"* tag.

E. All control wiring shall be color coded with wires of colors different from those used to designate phase wires.

F. Wiring for general 15 and 20 amp 120 volt and 277 volt branch circuit work shall be as follows unless otherwise indicated.

HOME RUN LENGTH AND WIRE SIZE						CIRCUIT LENGTH AND WIRE SIZE					
120 Volt			277 Volt			120 Volt			277 Volt		
0-60'	-	#12	0-175'	°	#12	0-100'	-	#12	0-200'	-	#12
60-100 '	-	#10	175 -350'	°	#10	100 &Up	-	#10	200 ' & Up	-	#10
100' & Up	-	#8	350> & Up	°	#8						

G. Circuit length as given above shall be the wire length between the first and last outlet on the circuit. Home run length as given above shall be the wire length between the first outlet and the panelboard. In accordance with the above, where the size of branch circuit conductors is increased by the minimum required by the NEC for the branch circuit rating, ensure that the termination provisions of all equipment connected to such circuits are listed as suitable for the conductor sizes involved.

H. Joints of #10 AWG and smaller shall be made with properly insulated solderless type pressure connectors. Where stranded conductors or multiple solid conductors are connected to terminals, solderless lugs manufactured by Thomas and Betts Company or equivalent shall be used.

I. Joints of #8 AWG and larger in power and lighting circuits shall be of the type indented into the conductor by means of a hand or hydraulic pressure tool. Connectors shall be Burndy *Hy-dent*, T&B *Sta-Kon*, or equivalent. Connectors for control wiring shall be Burndy *Hy-Lug*, or equivalent.

J. Branch circuits for lighting and power concealed in drywall partitions may be accomplished by utilizing Hospital Grade type MC (metal clad) cable. Cables shall be supported with appropriate hangers. Tie wire will not be accepted.

K. All circuits for exterior electric work shall be #10 AWG (minimum) and contain an extra #10 AWG (minimum) copper ground conductor. All exterior wiring shall be installed in conduit as specified above, unless otherwise noted on the Drawings.

3.4 INSTALLATION

A. Install wires and cables as indicated, according to manufacturer's written instructions and NECA's *Standard of Installation.*

B. Comply with NEC Article 517.

C. Pull Conductors: Use a UL-listed and manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway. Completely and thoroughly swab conduit system before installing conductors.

E. Install exposed cables, parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Division 26 Section, *Common Work Results for Electrical* and Division 26, Section, *Hangers and Supports.*

G. Seal around cables penetrating fire-rated elements according to Division 7, Section, *Penetration Firestopping* and Division 26 Section, *Electrical Firestopping.*

H. Identify wires and cables according to Division 26 Section, *Electrical Identification.*

I. Conductors installed in parallel shall be of equal lengths.

J. Wiring at Outlets: Install with at least 12 inches (300 mm) of slack conductor at each outlet.

K. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL Standard 486A.

L. The Contractor shall provide suitable installation equipment to prevent cutting and abrasion of conductor insulation. The Contractor shall use suitable cable guides, pulleys, and protective sleeving to prevent damage to cable during installation. Ropes used for pulling of wire and cable shall be made of polyethylene or other suitable non-metallic material. Pulling lines shall be attached to cable by means of either woven basket grips or pulling types attached directly to the conductors. Wire pulling lubricants, if used, shall conform to UL requirements applicable to the various insulations and raceway materials. The lubricants shall be certified by the manufacturer to be non-injurious to such insulation and materials.

M. Each feeder cable shall be labeled at terminals and at all accessible points in equipment and in pull boxes. Each control wire shall be labeled at both ends. Labels shall be self-sticking wire markers.

N. Riser cables shall have cable supports as required by Code.

0. For rubber and plastic-covered wire and cable, pulling compound Ideal Yellow 77 may be used.

P. Terminal lugs for wires #8 AWG and larger shall be T&B 54000 Series or Burndy *HY-Dent*,compression type, unless noted otherwise. One-hole lugs for #4/0 AWG and smaller. Two-hole lugs for all sizes #250 kcmil AWG and larger.

Q. Install wires and cables using braided rope larger than the cable being pulled to keep twists to a minimum.

R. Provide an insulated green ground wire with the feeder wiring for all three phase feeders shown or not shown. Equipment Grounding Conductor (EGC), sized per NEC, shall be provided for all circuits in PVC conduit.

S. Where conductors are shown on the plans to be direct-buried, they shall be 2, 3, or 4 conductors each, with separate self-contained ground conductor, cable type OF or USE.

T. Install electrical cables, wires, and connectors as indicated in compliance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in accordance with recognized industry practices.

U. Coordinate cable and wire installation work with electrical raceway and equipment installation work, as necessary for proper interface.

V. Conductors installed in runs within 6 inches of heating pipes or equipment shall be type AVA. No conductors shall be drawn into conduit until all work, which may cause cable damage, is completed.

W. All wiring over boilers and breechings, in fluorescent fixture channels, in Kitchen hoods, and in other high ambient temperature areas, shall be of types required by NEC.

X. During installation, do not deform cable by improper bending, stretching, twisting, kinking, or pinching, nor do any other abusive handling. Any failure to observe these instructions will be detected and corrected during the demonstrations following completion of the installation. All cable runs shall contain *S* loops or other means to accommodate expansion or contraction as required. Cable bends will have a radius not less than the value recommended by the cable manufacturer. Cable connected to electronic equipment in the system shall be tagged to show its function and the location of its other end. All labels shall be of durable material and securely fastened to the cable.

Y. Wiring of different system voltages shall not be mixed at pull boxes enclosures, surface metal raceway, wiretrough, etc., unless a barrier (separator) is provided between the differing systems.

3.5 CONNECTIONS

A. Conductor Splices: Keep to minimum.

B. Install splices and taps that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.

C. Use splice and taps connectors compatible with conductor material.

D. Use oxide inhibitor in each splice and tap connector for aluminum conductors.

E. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer.

F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

G. Wire splices and taps shall be adequate to carry full current rating of wire.

H. Splices and taps in wires up to #8 AWG shall be made with *Scotch-lok* or T&B PT Series or Ideal Wing Nut insulated electrical connectors. Wire nuts installed in wet location boxes shall be silicon gel-filled. For wires #8 AWG and larger, use copper solderless connectors covered with insulating molded body and then wrapped with electrical tape. Use twist-on wire connectors for connecting lighting fixtures and small motor leads up to #8 AWG wire.

I. Conductors shall be continuous from outlet to outlet, and no splices shall be made except within outlet or junction boxes. Junction boxes may be utilized where required. Wire connectors of insulating material or solderless pressure connections, properly taped, shall be utilized for all splices in wiring.

J. Splices in branch circuits and feeders shall be made where indicated or as required for the installation. All splices shall be accessible and made in enclosure approved for that purpose.

K. For splices in branch circuits and feeders, provide connectors as follows;

1. Wire Sizes #14 AWG to #10 AWG: Provide Ideal Model 74B or 76B or equivalent by T&B.
2. Wire Sizes #8 AWG and Larger: Provide Ideal Model Series AGP- and GT- or equivalent by Burndy, O-Z, or T&B.
3. All splices shall be enclosed in insulating molded thermoplastic, rubber, or rubberlike covers or shall be wrapped with Bishop No. 111 or equivalent insulating tape in accordance with the Manufacturer's directions.

L. Thoroughly clean wiring prior to installing lugs or connectors.

3.6 IDENTIFICATION

A. Interface with Other Work:

1. Identify wire and cable using Thomas and Betts Type WM vinyl markers.

2. Identify each phase and neutral conductor with its circuit number or other designation indicated on the Drawings in all junction, pull, terminal boxes, and cabinets.

B. Provide identification tags on each conductor entering panel, switch, junction box, and pull box to identify conductor.

C. Comply with the requirements of Division 26 Section, *Electrical Identification.*

D. Feeder Identification: Securely fasten nonferrous identifying tags or pressure-sensitive labels to all cables, feeders, and power circuits in pull boxes, handholes, panelboards, and at termination of cables.

1. Tags or labels shall be stamped or printed to correspond with markings on Contract Drawings or marked so that feeder or cable may be readily identified.

2. If suspended type tags are provided, they shall be attached by approximately 55-pound test monofilament line or slip-free plastic cable lacing units.

3.7 FIELD QUALITY CONTROL

A. Testing: On installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.

B. Correct malfunctioning conductors and cables at Project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

C. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.

D. Verify continuity of each branch circuit conductor.

E. Tests: All wire and cable Feeders and Branch Circuit insulation shall be tested after installation, and before connection to fixtures and appliance.

1. Tests shall be performed with a 500-volt megger, and conductors shall test free from short-circuits and grounds.

2. Conductors shall be tested phase-to-phase and phase-to-ground.

3. Furnish the instruments, materials, and labor required. Perform the tests in the presence of the Contracting Officer and Owner's Representative.

4. Actual test readings shall be recorded.

5. Submit all test reports to the Engineer for approval.

F. Demonstration: Subsequent to wire and cable hook-ups, energize circuit and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING

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 grounding of electrical systems and equipment and basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other Sections of these Specifications.

B. Bond the electrical service system neutral at service entrance equipment to grounding electrodes and metallic water service as supplementary.

C. Bond each separately-derived system neutral to nearest grounding system.

D. Provide communications system grounding conductor at point of service entrance and connect to grounding system.

E. Bond together system neutrals; service equipment enclosures; exposed non-current carrying metal parts of electrical equipment; metal raceway systems; grounding conductor in raceways; receptacle ground connectors; and plumbing systems.

F. Provide Grounding Equipment Protection per NEC 2012 - Article 517.

1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data for grounding rods, conductors, connectors and connection materials, and grounding fittings. Submit ground system manufacturer's recommended installation procedure for review.

C. Qualification data for firms and persons specified in *Quality Assurance* Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

D. Field tests and observation reports certified by the testing organization and indicating and interpreting the test reports for compliance with performance requirements.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70 - National Electrical Code.

B. Comply with UL 467 - UL Standard for Safety Grounding and Bonding Equipment.

C. Comply with ANSI/EEE C2 - National Electrical Safety Code.

D. Comply with ANSI/IEEE 32 - Requirements, terms and test procedures for neutral grounding devices.

E. Comply with IEEE Standard 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.

F. Comply with ANSI C33.8.

G. Comply with NEC 2012 - Article 517.

H. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms *Listed* and *Labeled:* As defined in the National Electrical Code, Article 100.

2. Listing and Labeling Agency Qualifications: A *Nationally Recognized Testing Laboratory* (NRTL) as defined in OSHA Regulation 1910.7.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Erico Inc.; Electrical Products Group.

2. Heary Brothers Lightning Protection Co.

3. Ideal Industries, Inc.

4. ILSCO.

5. O-Z/Gedney Co.

6. Raco, Inc.

7. Thomas & Betts, Electrical.

2.2 GROUNDING AND BONDING PRODUCTS

A. Governing Requirements: Where types, sizes, ratings, and quantities indicated are in excess of National Electrical Code (NEC) requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.

2.3 WIRE AND CABLE GROUNDING CONDUCTORS

A. Comply with Division 26 Section, *Conductors and Cables.* Conform to NEC Table 8, except as otherwise indicated, for conductor properties, including stranding.

B. Equipment Grounding Conductors: Insulated with green color insulation, size as indicated on the Drawings, or as required by 2012 National Electrical Code (NEC) Table 250-122, whichever is larger.

C. Grounding-Electrode Conductors: Stranded cable. Size as indicated on the Drawings, in the Specifications, or as required by 2012 National Electrical Code (NEC) Table 250-66, whichever is larger.

D. Underground Conductors: Bare, tinned, stranded, #4/0 AWG size minimum, except as otherwise indicated.

E. Bare Copper Conductors: Conform to the following:

1. Solid Conductors: ASTM B 3.

2. Assembly of Stranded Conductors: ASTM B 8.

3. Tinned Conductors: ASTM B 33.

2.4 MISCELLANEOUS CONDUCTORS

A. Grounding Bus: Bare, annealed-copper bars of rectangular cross section, minimum size 1/4-inch x 2-inch.

B. Braided Bonding Jumpers: Copper tape, braided No. 30 AWG bare copper wire, terminated with copper ferrules.

C. Bonding Straps: Soft copper, 0.05 inch (1 mm) thick and 2 inches (50 mm) wide, unless otherwise indicated.

2.5 CONNECTOR PRODUCTS

A. Mechanical Connectors

1. The mechanical connector bodies shall be manufactured from high strength, high conductivity cast copper alloy material. Bolts, nuts, washers and lockwashers shall be made of silicon bronze and supplied as a part of the connector body and shall be of the two-bolt type.

2. Split bolt connector types are NOT allowed unless indicated on the Drawings.

3. The connectors shall meet or exceed UL 467 and be clearly marked with the catalog number, conductor size and manufacturer.

B. Compression Connectors

1. The compression connectors shall be manufactured from pure wrought copper. The conductivity of this material shall be no less than 99 percent by IACS Standards.

2. The connectors shall meet or exceed the performance requirements of IEEE 837, latest revision.

3. The installation of the connectors shall be made with a compression, tool and die system, as recommended by the manufacturer of the connectors.

4. The connectors shall be clearly marked with the manufacturer, catalog number, conductor size and the required compression tool settings.

5. Each connector shall be factory filled with an oxide-inhibiting compound.

C. Exothermic Connections: Provide exothermic-weld kit selected per manufacturer's written instructions for specific types, sizes, and combinations of conductors and connected items.

2.6 GROUNDING ELECTRODES

A. Grounding Rods: Copper-clad rod with rigid steel core.

1. Size: 3/4 inch by 120 inches (19 by 3000 mm). Provide the number of rods required to obtain proper ground resistance.

2. Rods shall have a minimum of ten (10) mils of copper.

3. Ground rods shall be UL listed #467.

B. Plate Electrodes: Copper, square or rectangular shape. Minimum 0.10 inch (3 mm) thick, size as indicated.

PART 3 - EXECUTION

3.1 APPLICATION

A. Equipment Grounding Conductors: Comply with NEC Article 250 for types, sizes, and quantities of equipment grounding conductors, except where specific types, larger sizes, or more conductors than required by NEC are indicated.

1. Install Equipment Grounding Conductor (EGC) with circuit conductors for the items below in addition to those required by Code:

a. Feeders and branch circuits.

b. Lighting circuits.

c. Receptacle circuits.

d. Single-phase motor or appliance branch circuits.

e. Three-phase motor or appliance branch circuits.

f. Flexible raceway runs.

g. Armored and Metal-Clad (MC) cable runs.

2. Busway Supply Circuits: Install separate equipment grounding conductor from the grounding bus in the switchboard or distribution panelboard to equipment grounding-bar terminal on busway.

3. Computer Outlet Circuits: Install separate equipment grounding conductor in branch circuit runs from computer area power panels or power-distribution units.

4. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

5. Air-Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 120 V and above, including air cleaners and heaters. Bond conductor to each unit and to air duct.

6. Water Heater, Heat-Tracing, and Antifrost Heater Circuits: Install a separate equipment grounding conductor to each electric water heater, heat-tracing assembly, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components.

B. Comply with NEC 2012 - Article 517.

C. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide a No. 4 AWG minimum insulated grounding conductor in raceway from grounding-electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-inch by-2-inch by-12-inch (6-by-50-by-300-mm) grounding bus.

2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

D. Separately Derived Systems: Where NEC requires grounding, ground according to NEC Article 250-26.

E. Metal Poles Supporting Outdoor Lighting Fixtures: Ground pole to a grounding electrode in addition to separate equipment grounding conductor run with supply branch circuit.

3.2 INSTALLATION

A. General: Ground electrical systems and equipment according to NEC requirements, except where Drawings or Specifications exceed NEC requirements.

B. Electrical Room Grounding Bus: Space 1 inch (25 mm) from wall and support from wall 6 inches (150 mm) above finished floor, except as otherwise indicated.

C. Grounding Rods: Locate a minimum of 1-rod length from each other and at least the same distance from any other grounding electrode.

1. Drive until tops are 24 inches (50 mm) below finished floor or final grade, except as otherwise indicated.

2. Interconnect with grounding-electrode conductors using exothermic welds, and as otherwise indicated. Make these connections without damaging copper coating or exposing steel.

D. Grounding Conductors: Route along the shortest and straightest paths possible, except as otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

E. Underground Grounding Conductors: Use bare copper wire. Bury at least 24 inches (600 mm) below grade.

F. Metal Water Service Pipe: Provide insulated copper grounding conductors, sized as indicated, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding-clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Do not install a grounding jumper across dielectric fittings. Bond grounding-conductor conduit to conductor at each end.

G. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding-clamp connectors.

H. Grounding shall satisfy requirements of the applicable publications. All exposed noncurrent-carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductor in nonmetallic raceways, and grounded conductors of the wiring system shall be grounded.

I. The grounded conductor (neutral) of the wiring system shall be connected to the system grounding conductor at a single place in the system by removable bonding jumpers, sized according to the applicable provisions of the National Electrical Code. The grounded conductor (neutral) to the grounding conductor connection shall be located in the enclosure for the system's overcurrent protection or where otherwise indicated on the plans or specifications.

J. Ground buses and neutral buses in all distribution panelboards, switchboards, panelboards, and those provided in any equipment shall be isolated except where required to be connected as specified above for the service entrance and in transformer terminal compartments.

K. Equipment grounding conductors shall be extended from the ground bus in the distribution equipment to the receptacle, fixture or equipment lugs where they are provided. When not provided, they shall be connected to equipment enclosures. The connections shall be arranged such that removal of receptacle, the equipment ground conductors, or ground jumpers from ground busing, shall not affect the system ground.

L. Ground bus shall be provided as indicated on the Drawings or as necessary to provide termination for equipment ground conductor. Non-current carrying metal parts of electric equipment shall be effectively grounded by bonding to the bus. The ground bus shall be bonded to both the system neutral and the service ground.

M. Raceways shall not be considered as a grounding conductor. Each power, lighting, or control raceway shall have a separate equipment grounding conductor installed. Receptacles shall have a separate grounding pole. All switchgear and bus duct shall be equipped with a grounding bus separate from the neutral bus.

3.3 CONNECTIONS

A. General: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to assure high conductivity and to make contact points closer in order of galvanic series.

2. Make connections with clean, bare metal at points of contact.

3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.

4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.

5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections**.** Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding-Wire Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Non-Contact Metal Raceway Terminations: Where metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically non-continuous conduits at both entrances and exits with grounding bushings and bare grounding conductors, except as otherwise indicated.

E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. Where these requirements are not available, use those specified in UL 486A and UL 486B.

F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by manufacturer of connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

G. Moisture Protection: Where insulated grounding conductors are connected to grounding rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.4 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

A. Grounding System: Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes.

3.5 FIELD QUALITY CONTROL

A. Tests: Subject the completed grounding system to a megger test at each location where a maximum ground-resistance level is specified and at service disconnect enclosure grounding terminal. Measure ground resistance not less than 2 full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the 2-point method according to IEEE 81.

B. Maximum grounding to resistance values are as follows:

1. Equipment Rated 500 kVA and Less: 10 ohms.

2. Equipment Rated 500 to 1000 kVA: 5 ohms.

3. Equipment Rated More than 1000 kVA: 3 ohms.

4. Unfenced Substations and Pad-Mounted Equipment: 5 ohms.

5. Manhole Grounds: 10 ohms.

C. Excessive Ground Resistance: Where resistance to ground exceeds specified values, notify Owner promptly and include recommendations to reduce ground resistance and to

accomplish recommended work.

D. Report: Prepare test reports, certified by the testing organization, of ground resistance at each test location. Include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results. Submit all tests to the Engineer for approval.

3.6 ADJUSTING AND CLEANING

A. Restore surface features, including vegetation, at areas disturbed by work of this Section. Reestablish original grades, except as otherwise indicated. Where sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include top soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Maintain restored surfaces. Restore disturbed paving as indicated.

3.7 PROJECT RECORD DOCUMENTS

A. Accurately record actual locations of grounding electrodes and all primary grounding locations (i.e., water piping connection, building steel, test wells, etc.).

END OF SECTION 260526

SECTION 260527 - MEDIUM VOLTAGE CABLES

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 S U M M A R Y

A. This Section includes cables and related splices, terminations, and accessories for medium-voltage electrical distribution systems.

1.3 DEFINITIONS

A. NETA ATS: Acceptance Testing Specification.

1.4 GENERAL

A. Definition: Medium voltage power cables shall mean all cables rated 5 KV and above.

B. Provide all necessary cables as indicated on the drawings or as specified herein.

C. This specification covers medium voltage conductor shielded power cable suitable for use in wet and dry locations in conduit, underground duct systems, direct-buried and aerial installations.

1.5 RATING

A. Thirty-five [35] [25] KV cable for use on 33 [24.5] KV grounded system.

B. Fifteen (15) KV cable for use on 13.8 KV grounded system.

C. Five (5) kV cable for use on 4.16 kV grounded system.

1.6 CODES AND STANDARDS

A. All cables and accessories furnished under this Section shall be in accordance with the latest applicable standards of AEIC, ANSI, NEMA, IEEE, ICEA, OSHA, and the National Electrical Code. In addition, 33 KV cable and accessories shall be in accordance with the requirements of local utility company. The requirements of the local utility are in addition to, and in no way a waiver of, the applicable codes and standards.

B. Where any requirements specified herein or shown on the Contract Drawings exceed the listed standards, the Bidder shall adhere to the higher standard. In the case of conflict in requirements between two or more standards, the decision of the Engineer shall be final.

Code compliance is mandatory. Nothing in the Drawings and Specifications implies acceptance of work that does not comply with Codes.

C. Where applicable, all equipment and materials shall be listed and labeled by a nationally recognized testing laboratory with equipment listing and follow-up services.

1 American National Standards Institute (ANSI)
ANSI C2 National Electrical Safety Code

2. National Electrical Manufacturers Association (NEMA)
NEMA WC8 Ethylene-Propylene-Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

3. National Fire Protection Association
(NFPA) NFPA 70-1999 National Electrical Code

4. American Society for Testing and Materials (ASTM):

a. ASTM B-8 Concentric-Lay-Stranded Copper Conductors; Hard, Medium, or Soft.

b. ASTM B-231 Concentric-Lay-Stranded Aluminum Alloy 1350 Conductors.

D. Association of Edison Illuminating companies (AEIC): AEIC CS6 EP Rubber Insulated Wire Cable.

E. Insulated Cable Engineers Association (ICEA): ICEA S-68-516 Cables Rated 0-3500X Ozone Resistance.

F. Underwriters Laboratories (UL): UL-1072 List of Acceptable Sunlight Resistant PVC Compounds for use as insulating and/or jacketing material on listed outdoor flexible cords.

G. AEIC CS 5-1987: Specifications for Thermoplastic and Crosslinked Polyethylene Insulated Shielded Power Cables Rated 5 through 35 kV.

H. AEIC CS 6-1987: Specification for Ethylene Propylene Rubber Insulated Shielded Power Cables Rated 5 through 69 kV.

I. IEEE 48-1990: Standard Test Procedures and Requirements for High-Voltage Air- Conditioning Cable Terminations (ANSI).

J. IEEE 386-1995: Standard for Separable Insulated Connectors System for Power Distribution Systems above 600 V (ANSI).

K. IEEE 404-1993: Standard for Cable Joints for Use with Extruded Dielectric Cable Rated 5000-138,000 Volts and Cable Joints for Use with Laminated Dielectric Cable Rated

2500500,000 Volts (ANSI).

L. IEEE 576-1989: Recommended Practice for Installation, Termination, and Testing of Insulated Power Cable as Used in the Petroleum and Chemical Industry (ANSI).

M. IEEE C2-1996: National Electrical Safety Code (ANSI).

N. ICEA T-31-610-1994: Guide for Conducting a Longitudinal Water Penetration Test for Sealed Conductor.

0. NETA ATS-1995: Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

P. NEMA WC 7-88 (ICEA S-66-524): Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

Q. NEMA WC 8-88 (ICEA S-68-516): Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

R. NEMA WC 26-90 (including Revision 1 - 1993): Wire and Cable Packaging.

S. NFPA 70-96: National Electrical Code.

1.7 GENERAL REQUIREMENTS

A. All materials supplied by the Contractor shall be new, of recent manufacture, and of the highest commercial grade as specified. They shall be resistant to moisture and corrosion to withstand their environment and operational conditions with minimum maintenance and long life.

1.8 QUALIFICATIONS

A. The manufacturer of the materials specified herein shall have at least ten years of demonstrated experience in the manufacture of the specified product.

B. The manufacturer shall be a company specializing in the manufacture of medium voltage cable and/or accessories with minimum five years documented experience in producing cable and/or accessories similar to those specified below.

C. The cable materials and manufacturer shall meet or exceed all applicable requirements of the latest editions of ICEA Standard S-68-516, AEIC and NEMA Standards.

D. The cable shall be manufactured using the triple tandem extrusion process in which all layers, from the conductor to, and including, the insulation tape shield, are installed at essentially the same time without an intervening storage period on reels or other storage devices.

E. Factory Tests:

1. Cable shall be factory-tested at high voltage AC, high voltage DC, and for corona discharge in accordance with ICEA requirements.

2. Certification of satisfactory completion of factory tests for cables shall be submitted to the Engineer at the time of cable delivery.

1.9 SUBMITTALS

A. Submit product data indicating cable and accessory construction, materials and ratings.

B. Submit Manufacturer's certificate stating factory test voltage.

C. Submit Manufacturer's installation instructions.

D. Submit Manufacturer's Certificate stating that medium voltage cable meets or exceeds all requirements.

E. Manufacturer's instructions for storage, handling, protection, examination and field testing of cables and accessories before initial energization.

F. Samples: 16-inch (400-mm) lengths of each type of cable specified.

G. Product Certificates: Signed by manufacturers of cables and accessories certifying that the products furnished comply with requirements.

H. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

I. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

J. Product Test Reports: Indicate compliance of cables and accessories with requirements based on comprehensive testing of current products.

K. Medium Voltage Cable Terminating and Splicing Workman's Competency: In order to establish workman's competency regarding medium voltage cable terminating and splicing, the Contractor shall be required to submit the following within 30 days prior to commencement of termination of work.

1. Documentation to verify that the individual has completed a termination and splice of the types to be installed, under the supervision of the cable accessory manufacturer, or his representative.

2. Documentation that the dummy termination and splice have undergone and passed the following tests, to be performed by the splice kit supplier. These results shall be attached for review.

Test	Minimum Value
Discharge Ext. Value with 3 pc or less	13 kV

AC Withstand, 1 minute	35 kV

Test	Minimum Value
DC Withstand, 15 minutes	65 kV

3. A statement of the number of years in which the individual has been splicing/terminating medium voltage cables.

L. A list of the last three jobs where specific splices/terminations were installed within the last 12 consecutive months. This list shall include splice/termination manufacturer, catalog number, cable type and the quantity installed.

M. Maintenance Data: For cables and accessories to include in the maintenance manuals specified in Division 1.

1. Include periodic tests of cables in service.
2. Include operation of fault indicators, separable insulated connectors, and accessories.

1.10 QUALITY ASSURANCE

A. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain cables and accessories through one source from a single manufacturer.

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

E. Comply with IEEE C2 and NFPA 70.

1.11 PROJECT RECORD DOCUMENTS

A. Submit record documents under provisions of Division 1.

B. Accurately record exact sizes, lengths, types, quantities, and locations of cables. Indicate where all splices and terminations are located for each cable.

1.12 DELIVERY, STORAGE AND HANDLING

A. Deliver products to site under provisions of Division 1 and comply with NEMA WC 26.

B. Store and protect products under provisions of Division 1. Store cables and reels on elevated platforms in a dry location.

C. Accept cable and accessories on site in manufacturer's packages and inspect for damages.

D. Protect cable and accessories from weather by covering with opaque plastic or canvas. Provide ventilation to prevent condensation.

E. Cable shall be stored according to manufacturer's recommendations as a minimum. In addition, cable must be stored in a location protected from vandalism and weather. If cable is stored outside, it must be covered with opaque plastic or canvas with provision for ventilation to prevent condensation and for protection from weather. If air temperature at cable storage location will be below 40 degrees F, the cable shall be moved to a heated (50 degrees F minimum) location. If necessary, cable will be stored off site.

1.13 SITE REQUIREMENTS

A. Provide responsibility for all safety requirements on the work site.

B. Comply with OSHA Confined Space Regulations, 8CCR 5156-5158.

C. Barricade open utility holes and pullboxes at all times. Provide for safe flow of traffic and pedestrians.

D. Provide for continuous, mechanically supplied, fresh air to manholes and vaults where workers are inside.

E. All switching of existing circuits shall be performed. Verify that circuits are de-energized and locked out prior to starting work.

F. Scheduled outages that may be required to complete the work will be coordinated with the Owner.

G. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect/Engineer at least two (2) days in advance of proposed utility interruptions.

2. Do not proceed with utility interruptions without Engineer/Architect's written permission.

1.14 LEED REQUIREMENTS

A. Refer to Division 1 Section LEED Requirements for description of work under this Division affected by LEED requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer must be able to meet these Specifications as well as the latest edition of Association of Edison Illuminating Company (AEIC) Specification CS6 and other applicable industry standards and specifications.

B. The proposed 35 [25] KV cable must be approved acceptable by local utility company.

C. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cables:

a. Okonite Company (The).

b. Prysmian (formally Pirelli) Cable Corporation; Power Cable Division.

c. American Insulated Wire Corporation; Leviton Manufacturing Company.

d. BICC Brand-Rex Company.

e. Carol Cable Company, Inc.

f. Kerite Company (The); Hubbell, Inc.

g. Rome Cable Corporation.

h. Southwire Company.

2. Cable Splicing and Terminating Products and Accessories:

a. 3M Company; Electrical Products Division.

b. Elastimold.

c. Engineered Products Company.

d. G & W Electric Company.

e. Mac Products, Incorporated.

f. MP Husky Corporation.

g. Raychem Corporation; Energy Division.

h. RTE Components; Cooper Power Systems, Inc.

i. Scott Fetzer Company; Adalet-PLM Subsidiary.

j. Thomas & Betts Corporation.

2.2 MEDIUM VOLTAGE CABLE - SHIELDED

A. Usage: this cable shall be used for all above and underground applications (except for jumper cable applications. See "Jumper Cable" below) and shall be contained in conduit or other raceways. It may be used in cable trays in electrical vaults only.

B. Cable: Single conductor, insulated cable rated [5] [15] KV, 133% insulation level, ungrounded, NEC-UL Type MV-90. Sizes as indicated on the Drawings.

C. Conductor: Soft copper, annealed, uncoated, Class B compressed or concentric stranded, having nominal direct-current resistance equal to or less than that required in Section 2.5.2 and Table 2-12 of ICEA S-68-516.

D. Conductor Shield: Copper tape, helically applied over extruded semiconductor with resistivity requirements of Section 2.4 of ICEA S-68-516. Material shall be clean stripping from the conductor and firmly bonded to the overlying insulation.

Designer Note: USE THE FOLLOWING PARAGRAPH FOR 5 KV APPLICATIONS

E. Insulation: Extruded EPR (ethylene propylene rubber), rated at 5 KV, 133 percent insulation level, minimum nominal thickness of .115 inches, minimum insulation K factor of 50,000 megohms per 1000 foot length. Manufacturer's Certification of this value shall be a part of submittal for cable approval.

Designer Note: USE THE FOLLOWING PARAGRAPH FOR 15 KV APPLICATIONS

F. Insulation: Extruded EPR (ethylene propylene rubber), rated at 15 KV, 133 percent insulation level, minimum nominal thickness of .220 inches, minimum insulation K factor of 50,000 megohms per 1000 foot length. Manufacturer's Certification of this value shall be a part of submittal for cable approval.

G. Insulation Shield: the insulation shield shall consist of an extruded semiconducting layer directly over the insulation and a coated copper tape over the semiconducting covering. The tape shall be at least 2.5 mils (0.0635 mm) thick and be spiral wrapped with a 12.5 percent overlap. The insulation shield shall meet all requirements of ICEA Section 4.1.1.

H. Jacket: Black chlorosulfonated polyethylene (CSPE), Polyvinyl Chloride (PVC) or Chlorinated Polyethylene (CPE), all rated AUSE1', with a minimum jacket thickness - 80 mils (2.03 mm), meeting all requirements of ICEA.

I. Cable Rating: Continuous duty at 90 degrees C, wet or dry locations, suitable for underground duct installations, NEC-UL Type MV-90, Type USE.

2.3 MEDIUM VOLTAGE CABLE - UNSHIELDED (JUMPER CABLE)

A. Usage: This cable may only be used between equipment in the same vicinity such as between the primary switch and the transformer where adequate through-air clearance can be achieved between the conductors. In general, it is not designed for and shall not be used in metallic raceways.

B. Cable: Single conductor, flexible, non-shielded, insulated cable-rated 15 KV, ungrounded. Sizes as indicated on the Drawings.

C. Conductor: Soft annealed copper, uncoated, concentric stranded, having nominal direct-current resistance equal to or less than that in Section 2.5.2 and Table 2-12 of ICEA 5-68516.

D. Conductor Shield: Extruded semiconductor with resistivity requirements of Section 2.4 of ICEA S-68-516. Material shall be clean stripping from the conductor and firmly bonded to the overlying insulation.

E. Insulation: Extruded EPR (ethylene propylene rubber), rated at 15 KV, minimum thickness of .175 inches, minimum insulation K factor of 50,000 megohms per 1000 foot length. Manufacturer's certification of this value shall be a part of submittal for cable approval.

F. Cable Rating: Continuous duty at 90 degrees C dry locations.

2.4 GENERAL CABLE REQUIREMENTS:

A. Cable shall be single conductor shielded, NEC UL Type MV-90, Class B stranded bare copper, covered with an extruded layer of semi-conducting ethylene-propylene based elastomer (EPR).

B. The insulation shall be an ethylene-propylene elastomer which shall meet or exceed the electrical and physical characteristics of ICEA-S-68-516 and AEIC CS6 (latest edition). The insulation thickness shall be 115 mils for 5 KV, 220 mils for 15kV, and 345 mils for 35kV class service.

DESIGNER NOTE: ON UNGROUNDED SYSTEMS, INCREASE INSULATION LEVELS BY 133%.

C. The insulating compound shall have a maximum ethylene content of 72% by weight and shall not contain any polyethylene.

D. The insulation screen shall be an extruded layer of semi-conducting ethylene-propylene based material with a volume resistivity not in excess of 10 ohm-meters (at 90 degrees C) and shall be applied in accordance with AEIC CS6.

E. Both inner and outer semi-conducting compounds shall have an elongation after air oven aging at 121 degrees C for 160 hours of 100 percent and a brittleness temperature not warmer than -50 degrees C. The semi-conducting layers and insulation shall be applied using the triple tandem extrusion process.

F. A 5 mil base copper tape shield shall be applied over the outer semi-conducting layer with a nominal 12.5 percent overlap.

G. The overall jacket shall be polyvinylchloride **[polyethylene]** applied in accordance with ICEA S-68-516 Part

H. A permanent marking on the jacket shall indicate cable type, size, conductor type, and rated voltage.

2.5 TERMINATIONS

A. The selected termination system shall be approved by the cable manufacturer. Possible types of acceptable terminators include:

1. Potheads: IEEE 48; Class 1 termination for one conductor with porcelain insulators, cable connector and aerial lug, sealed cable entrance and support, and insulating compound.

2. Porcelain Insulator Cable Terminators: IEEE 48; Class 1. Kit form, suitable for use with cable specified.

3. Cast Epoxy Cable Termination: IEEE 48; Class 1. Kit form, suitable for use with cable specified, including stress cone, shield ground connection, epoxy resin molding material, and accessories and molds necessary for proper application.

4. Modular Molded Rubber Termination: IEEE 48; Class 1. Kit form, suitable for use with cable specified, including stress cone, ground clamp, non-tracking rubber skirts, connector, rubber cap, and aerial lug. Termination shall be hot or cold shrink type with internal stress relief tube to distribute electric field (10% to 90% equipotential lines) over entire length of skirted insulator.

5. Tape Termination: IEEE 48; Class 1. Kit form, suitable for use with cable specified, including semi-conductive tape, stress control tape, splicing tape, vinyl

plastic tape, stress cone, mechanical ground straps, and cable preparation kit.

6. Raychem Type HVT, heat shrinkable termination kits.

B. Submittal for approval shall show electric field distribution (via equipotential lines) of termination device.

C Lugs shall be copper, long barrel, two-hole or four-hole and rated for the voltage applied. The lugs shall match the pads on the equipment to which the cable will be mounted. For example, if the equipment has a four-hole pad, the cable lug shall be four-hole type.

D. If there will be more than one cable on an equipment pad, approved spiders (or spacers) must be used. Cable attachment to equipment must match the equipment manufacturers UL labeling requirements (if the equipment is UL listed) as a minimum. Unless the equipment is designed or listed for it, cable lugs may not be placed back-to-back on the equipment pad. In all cases, the termination and equipment must be taped with approved anti-tracking tape.

E. Modular Molded Shrink Type Splice; IEEE 404-1986; Class 1; (5)(15) KV. Kit form, suitable for use with cable specified, including slip-on type flexible polymer or silicon rubber insulator. Splice shall be hot or cold shrink type with internal stress relief tube to distribute electric field (10 percent to 90 percent equipotential lines) over entire length of insulating material.

F. Molded body shall contain a built-in internal semiconducting layer which covers and contacts the splice barrel and the cable insulation layer to prevent electrical stress buildup inside the body. This semiconducting layer shall be bonded to and covered with a cured EPDM rubber or polymer insulating layer which, in turn, shall be bonded to and covered with a semiconducting layer and metallic shield and jacket.

G. Splicing sleeves shall be long barrel type and rated for the voltage applied.

H. The completed splice shall be approved for underground direct burial and water immersion service.

2.6 SPLICE KITS

A. Connectors: IEEE 404, compression type, as recommended by cable or splicing kit manufacturer for the application.

B. Splicing Products: As recommended in writing by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors and splices specified. Include all components required for complete splice, with detailed instructions.

1. Combination tape and cold-shrink rubber sleeve kit with rejacketing by cast-epoxy resin encasement or other waterproof, abrasion-resistant material.

2. Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer heat-shrink jacket.

3. Premolded, cold-shrink rubber, in-line splicing kit.

4. Premolded EPDM splicing body kit with cable joint sealed by interference fit of mating parts and cable.

C. Modular Molded Shrink Type Splice; IEEE 404-1986; Class 1; (5)(15) KV. Kit form, suitable for use with cable specified, including slip-on type flexible polymer or silicon rubber insulator. Splice shall be hot or cold shrink type with internal stress relief tube to distribute electric field (10 percent to 90 percent equipotential lines) over entire length of insulating material.

D. Molded body shall contain a built-in internal semiconducting layer which covers and contacts the splice barrel and the cable insulation layer to prevent electrical stress buildup inside the body. This semiconducting layer shall be bonded to and covered with a cured EPDM rubber or polymer insulating layer which, in turn, shall be bonded to and covered with a semiconducting layer and metallic shield and jacket.

E. Splicing sleeves shall be long barrel type and rated for the voltage applied.

F. The completed splice shall be approved for underground direct burial and water immersion service.

2.7 SOLID TERMINATIONS

A. Multiconductor Cable Sheath Seals: Type recommended by Seal Manufacturer for type of cable and installation conditions, including orientation.

1. Compound-filled, cast-metal body, metal-clad cable tetminator for metal-clad cable with external plastic jacket.

2. Cold-shrink sheath seal kit with preformed sleeve openings sized for cable and insulated conductors.

3. Heat-shrink sheath seal kit with phase-and ground-conductor rejacketing tubes, cable-end sealing boot, and sealing plugs for unused ground-wire openings in boot.

4. Cast-epoxy-resin sheath seal kit with wrap-around mold and packaged, 2-part, epoxy-resin casting material.

B. Conductor Terminations: Comply with IEEE 48, as indicated. Insulation class is equivalent to that of cable. Terminations for shielded cables include a shield ground strap.

1. Class 1 Termination for Shielded Cable: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone rubber, insulator modules; shield ground strap; and compression-type connector.

2. Class 1 Termination for Shielded Cable: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking

skirt modules; and compression-type connector.

3. Class I Termination for Shielded Cable: Modular type, furnished as a kit, with stress-relief shield terminator; multiple-wet-process, porcelain, insulator modules; shield ground strap; and compression-type connector.

4. Class 1 Termination for Indoor Shielded Cable; Kit with stress-relief tube, nontracking insulator tube, shield ground strap, compression-type connector, and end seal.

5. Class 2 Termination for Shielded Cable; Kit with stress-relief tube, nontracking insulator tube, shield ground strap, and compression-type connectors. Include silicone-rubber tape, cold-shrink rubber sleeve, or heat-shrink plastic-sleeve moistureseal for end of insulation whether or not supplied with kits.

6. Class 3 Termination for Shielded Cable: Kit with stress cone and compression-type connector.

C. Termination for Nonshielded Cable; Kit with compression-type connector. Include silicone- rubber tape, cold-shrink rubber sleeve, or heat-shrink plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.

2.8 SEPARABLE INSULATED CONNECTORS

A. Separable Insulated Connectors: Modular System complying with IEEE 386. Disconnecting, single-pole, cable terminators and matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

B. Terminations at Distribution Points: Modular type, consisting of terminators installed on Cables and modular, dead-front, terminal junctions for interconnecting cables.

C. Load-Break Cable Terminators: Elbow-type units with 200-A load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

D. Dead-Break Cable Terminators: Elbow-type unit with 600-A continuous-current rating, designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

E. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless-steel mounting brackets, and attaching hardware.

1. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.

2. Portable Feedthrough Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.

3. Grounding Kit: Jumpered elbows, portable feedthrough accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.

4. Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable-elbow terminator.

F. Test-Point Fault Indicators: Arranged for installation in test points of load-break separable connectors. Self-resetting indicators capable of being installed with a shotgun hot stick and tested with a test tool. Current-trip ratings as indicated.

G. Tool Set: Shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.

2.9 ARC-PROOFING MATERIALS

A. Tape for First Course on Metal Objects: Ten-mil (250 micrometer) thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.

B. Arc-Proofing Tape: Fireproofing tape, flexible, conformable, intumescent to 0.3 inch (8 mm) thick, compatible with cable jacket.

C. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1/2 inch (13 mm) wide.

2.10 FAULT INDICATORS

A. Indicators: Automatically-reset fault indicator with inrush restraint feature, arranged to clamp to cable sheath and provide a display after the cable has faulted. Instrument immune to heat, moisture, and corrosive conditions and recommended by manufacturer for installation conditions. Indicators have current-trip ratings and quantities as indicated.

B. Resetting Tool: Designed for use with fault indicators, with moisture-resistant storage/carrying case.

2.11 SOURCE QUALITY CONTROL

A. Test and inspect cables according to ICEA S-97-682 and ICEA S-94-649 before shipping.

B. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of 5 psig (35 kPa).

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine raceways to receive medium-voltage cables for compliance with requirements for installation tolerances and other conditions affecting performance of cables. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 CABLE PULLING

A. Prior to pulling cable, a mandrel/swab 1/4 inch smaller than the duct diameter shall be pulled through duct run to insure adequate opening of duct run. Thoroughly swab conduits to remove foreign material before pulling cables.

B. Cables shall not be pulled into outside (exterior) or underground systems from an outside (exterior) or underground location when the outside (exterior) air temperature is below 40 degrees Fahrenheit.

C. Furnish all required installation tools to facilitate cable pulling without damage to the cable jacket. Such equipment is to include, but not be limited to, sheaves, winches, cable reels and/or cable reel jacks, duct entrance funnels, pulling tension gauge, and similar devices. All equipment shall be of substantial construction to allow steady progress cone pulling has begun. Makeshift devices which may move or wear in a manner to pose a hazard to the cable shall not be used.

D. Cable ends shall be sealed and firmly held in the pulling device during the pulling operation.

E. Cable pulling shall be done in accordance with cable manufacturer's recommendations, except as modified herein, and ANSI/IEEE C2 standards. Manufacturer's recommendations shall be a part of the cable submittal. Recommended pulling tensions shall not be exceeded. Pulling bending radius shall not be less than that determined by the manufacturer of the NEC. Actual pulling tensions shall be continuously monitored and permanently recorded in a log and submitted to the Engineer at the end of the project. Restrictions of pulling bending radius dimensions shall be strictly observed. Training bending radius shall not be less than 12 times cable diameter. Any cable bent or kinked to radius less than recommended dimension shall not be installed.

F. During pulling operation, an adequate number of persons shall be present to allow cable observation at all points of duct entry and exit as well as to feed cable and operate pulling machinery.

G. Cable Pulling: Test existing duct lines with a mandrel and thoroughly swab out to remove foreign material before the pulling of cables. Pull cables down grade with the feed-in point at the manhole or buildings of the highest elevation. Use flexible cable feeds to convey cables through the manhole opening and into the duct runs. Cable slack shall be accumulated at each manhole or junction box where space permits by training the cable around the interior to form one complete loop. Minimum allowable bending radii shall be maintained in forming such loops.

H. Cable pulling tensions shall not exceed the maximum pulling tension recommended by the cable manufacturer.

I. Pulling lubricant shall be used to ease pulling tensions. Lubricant shall be of a type which is non-injurious to the cable material used. Lubricant shall not harden or become adhesive with age.

J. Lubricants for assisting in the pulling of jacketed cables shall be those specifically recommended by the cable manufacturer. Cable lubricants shall be petroleum grease for lead-covered cables (soap-stone, graphite, or talc for rubber jacketed cables). The lubricant shall not be deleterious to the cable sheath, jacket, or outer coverings.

K. Avoid abrasion and other damage to cables during installation.

L. Where cables are left in manhole or switchgear overnight or more than 8 hours prior to termination, the cable ends shall be sealed with paraffin or shrink wrap caps and supported in a manner which will prevent entrance of moisture into the cable. Cable shall be terminated and energized as soon as possible.

3.3 INSTALLATION

A. The firm shall be a company specializing in installation of medium voltage cable and accessories with a minimum of five years documented experience in installation of the type of cable and accessories described below.

B. The electricians employed for this work shall be experienced in medium voltage cable installation. Workmen involved in splicing and termination of cables shall have been specifically trained in the procedures required for the splices and terminations used in this project. At the discretion of the Engineer, documentation of experience and/or training in medium voltage cable splicing and termination shall be furnished. At the Engineer's discretion, the electricians making up terminations or splices shall make up a sample splice and/or termination to be used to determine the capability of the electrician(s) involved.

C. Install cables as indicated, according to manufacturer's written instructions and IEEE 576.

D. Install exposed cables, parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Install direct-buried cables on leveled and tamped 3-inch (75-mm) bed of clean sand at bottom of trench. Separate cables crossing other cables or piping from those items by a minimum of 4 inches (100 mm) of tamped earth. Install permanent markers at ends of cable runs, changes in direction, and buried splices.

F. Install "buried cable" warning tape 12 inches (305 mm) above cables.

G. Install separable insulated-connector components where indicated according to manufacturer's written instructions. Provide the following quantities of components:

1. Protective Cap: Install at each Terminal Junction, one on each terminal to which no feeder is indicated to be connected.

2. Portable Feed-through Accessory: 3.

3. Standoff Insulator: 3.

3.4 CABLE ROUTING IN UTILITY HOLES AND EQUIPMENT

A. Certain utility holes, as indicated on the drawings, shall have the cable looped around the walls. In such cases, the cable shall circle the manhole at least 360 degrees. Where utility holes are not to be looped, cable shall be routed on the walls with the longest distance between points of entry and exit.

B. All new and existing cable in utility holes shall be secured to racks on the utility hole walls. Cables shall be secured to racks with split porcelain insulators and clamps. Insulator openings shall be of adequate size to contain all three phases and the ground of a given circuit. Fastening cables directly to support brackets with wire or plastic ties will not be accepted. Support cables at 4' intervals with galvanized steel racks and channels and porcelain insulators or non-metallic cable racks. Cable weight shall not rest on terminations.

C. Cables within switchgear shall be routed in a manner which will allow adequate room for bending and terminating cables. Cables must be secured in a manner which will not result in cable weight being placed on the termination electrical joint. Cable support shall be made in a manner that does not force cable against grounded metal or which compresses cable diameter. Cable training bending radius shall be at least 12 times cable diameter.

D. Jumper cable shall be routed in a manner that prevents it from contacting any metallic surface.

E. Installation of cables in utility holes, handholes and vaults: Do not install cables utilizing the shortest route, but route along those walls providing the longest route and the maximum spare cable lengths. Form all cables to closely parallel walls, not to interfere with duct entrances, and support on brackets and cable insulators at a maximum of 18 inches. In existing utility holes; handholes and vaults where new ducts are to be terminated or where new cables are to be installed, the existing installation of cables, cable supports and grounding as required for a neat and workmanlike installation with all cables properly arranged and supported. Support cable splices in underground structures by racks on each side of the splice. Locate splices to prevent cyclic bending in the spliced sheath. Install cables at middle and bottom of cable racks, leaving top space opening for future cables, except as otherwise indicated for existing installations. Provide one spare three-insulator rack arm for each cable rack in each underground structure. (Provide cable racks in each underground structure through which cable is run.)

F. Ground metallic non-current carrying components such as cable racks, switches, and transformers. Use a #6 solid copper conductor, minimum.

G. In utility holes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.

3.5 TERMINATING AND SPLICING

A. Cable Terminating: Protect terminations of insulated power and lighting cables from accidental contact, deterioration of coverings and moisture by the use of termination devices and materials. Install all terminations of insulated power and lighting cables (cable splices) (pot heads) (high voltage terminations) in accordance with the manufacturer's requirements. Make terminations using materials and methods as indicated or specified herein or as designated by the written instructions of the cable manufacturer and termination kit manufacturer. Keep cable ends sealed prior to splicing or termination to prevent the entrance of moisture.

B. Splices in High Voltage Cables: Splices shall be suitable for continuous immersion in water and shall be made only in accessible locations in manholes or handholes. Clearly mark splices buried directly in earth by an identification slab.

C. Certification: High voltage cable splicer/terminator certification of competency and experience shall be submitted thirty (30) days before splices or terminations are made in high voltage cables. Splicer/termination experience during the immediate past three years shall include performance in splicing and terminating cables of the type and classification being provided under this contract.

D. Cast-Type Splice Methods: Cast-type splice insulation shall be provided by means of a molded casting process employing a thermosetting epoxy resin insulating material which shall be applied by a gravity-poured method or by a pressure-injected method. The component materials of the resin insulation shall be in a packaged form ready for convenient mixing without removing from the package. Do not allow the cables to be moved until after the splicing material has completely set.

E. Kit Methods: High voltage splices shall be made using *kit* which shall be the product of one Manufacturer and shall have the approval in writing of the manufacturer of the cable which is to be spliced. Provide the Contracting Officer Quality Control Representative with a copy of the Manufacturer's instructions before splicing is started. Splices shall be made only in utility holes and handholes.

F. Splices in Shielded Cables: Splices in shielded cables shall include covering the spliced area with metallic tape, or like material, to the original cable shield and by connecting it to the cable shield on each side of the splice. Provide a No. 6 AWG bare copper ground connection brought out in a watertight manner and grounded to a 3/4-inch by 10-foot ground rod as part of the splice installation. Wire shall be trained to the sides of the enclosure in a manner to avoid interference with the working area.

G. Splices are to be held to a minimum. Splice locations shall be determined by cable lengths available, pulling conditions and termination points. Splice locations are to be listed by the Contractor prior to cable purchase and a listing of such locations submitted to the Engineer for approval before final cable lengths are determined.

H. Only experienced electricians shall be employed in this phase of the work. Refer to *Quality Assurance* above.

I. Follow cable manufacturer's and splice or termination manufacturer's installation instructions and ANSUIEEE C2 standards.

J. Clean, white lint-free gloves shall be used to handle the end of the cable during tape wrapping procedures.

K. Termination or splicing of the copper conductors (both power and ground conductors) shall be made only with tool-applied compression (swaged) fittings.

L. Ground system connections:

1. Cable to Bus: Compression cable fitting bolted to bus with lock washers under nut.

2. Cable to Ground Rod: Approved bolted fitting with backing plate between cable and rod.

M. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware according to manufacturer's written instructions.

N. Splice or termination failure upon high potential acceptance test will require complete reconstruction of the joint to Manufacturer's Specifications. Make sure that there is enough free cable at each termination or splice for two more terminations or splices to be performed.

0. Install Scotch #70 tape for anti-tracking on all exposed terminations.

P. All splices and terminations are to be tagged using embossed plastic tags with plastic attachment devices indicating date splice or termination was made, name of electrician involved, name of Contractor installing cable, feeder number and circuit to and from data.

Q. All cable splices in manholes shall be supported on both sides of the splice within 2'0" of the splice. Splices shall not rely on cable for support.

R. Lugs shall be bolted to termination pads in equipment using corrosion-resistant bolts, nuts, and washers. Use Belleville washers for bolting aluminum to aluminum, and lock washers for bolting copper to copper or as recommended by equipment manufacturer. Washers shall be in the lug side. Torque to Manufacturer's recommendations.

S. Install splices at pull points and elsewhere as indicated. Use standard kits. Comply with kit manufacturer's written instructions.

T. Install terminations at ends of conductors and seal multiconductor cable ends with standard kits. Comply with kit manufacturer's written instructions and with classes of terminations indicated.

3.6 FIRE-PROOFING AND ARC PROOFING

A. Fireproofing (Arc Proofing) of Cables in Utility Holes, Handholes, and Vaults: All wire and cables which will carry current at 2200 volts or more in manholes, handholes, and vaults shall be fire-proofed.

B. Exposed cables in utility holes shall be fireproofed. Entire installation shall conform to Manufacturer's recommendations.

C. Arc proofing material shall be Scotch #77 electrical arc and fireproofing tape, or approved equal.

D. Install the fireproofing on the cables as follows:

1. Install tightly applied fireproofing tape, approximately 1/16-inch thick by 1-1/2 inches wide minimum, around each feeder spirally on one-half-lapped wrapping.

2. Install the tape with the coated side towards the cable and extend it not less than one inch into each duct.

3. Install random wrappings of Scotch #69 glass cloth tape around the installed fire- proofing tape per Manufacturer's instructions to prevent it from unraveling.

E. Fireproofing Tape: Strips of fireproofing tape approximately 1/16-inch thick by 3 inches wide shall be wrapped tightly around each cable spirally in half-lapped wrapping, or in two butt-joined wrappings with the second wrapping covering the joints in the first. The tape shall be applied with the coated side toward the cable and shall extend one-inch into the ducts. To prevent unraveling, the fireproofing tape shall be random wrapped the entire length of the fireproofing with pressure sensitive glass cloth tape. The fireproofing tape shall consist of a flexible, conformable fabric having one side coated with flame retardant flexible, polymeric fabric having one side coated with flame retardant, flexible, polymeric coating and/or a chlorinated elastomer not less than 0.050 inch thick and shall weigh not less than 2.5 pounds per square yard. The tape shall be noncorrosive to cable sheath, shall be self-extinguishing, and shall not support combustion. The tape shall not deteriorate when subjected to oil, water, gases, salt water, sewage and fungus.

F. Arc Proofing: Arc-proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials, unless otherwise indicated. Apply as follows and as recommended by manufacturer of arc-proofing tape:

1. Clean cable sheath.

2. Wrap metallic cable components with 10-mil (250-micron) pipe-wrapping tape.

3. Smooth surface contours with electrical insulation putty.

4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.

5. Band arc-proofing tape with 1-inch-(25-mm-) wide bands of half-lapped,

adhesive, glass-cloth tape 2 inches (50 mm) o.c.

3.7 PHASING

A. Verify by *hot phase* test that cables on loop and tie circuits are matched phase-to-phase at every splice or termination that occurs at an open point. Use an approved live-line phasing meter and follow safety and switching procedures. This test may only be performed by personnel experienced in and qualified for testing of energized circuits. Do not rely on color markings for assurance of proper phasing.

B. Verify correct phase rotation when cables on radial circuits are replaced. Use approved secondary voltage rotation tests or verify that the rotation of existing motors is correct.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing agency to perform field quality-control testing.

B. Testing: On installation of medium-voltage cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.3.2.

2. Certify compliance with test parameters.

C. Correct malfunctioning cables and accessories at project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

D. Test and inspect cables according to NEMA WC 7 (ICEA S-66-524) and NEMA WC8 (ICEA S-68-516) before shipping.

E. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of 5 psig (35 kPa).

F. Tests shall be performed on completed cable in accordance with ICEA S-68-516 and AEIC CS6 (latest edition) as specified.

1 .	Conductor Resistance	per AEIC Paragraph 1.2
2 .	AC Withstand (5 minutes)	5 kV - 22 kV
3.		15 kV - 44 kV
4.		35 kV -69 kV
5 .	IR Constant (at 15.6 C), min.	50,000 megohms - 1000 feet
6 .	DC Withstand (15 min.)	5 kV - 45 kV
7.		15 kV -80 kV
8.		35 kV - 125 kV
9 .	Partial Discharge	Per AEIC, 5 pc max. at 4 times rated voltage

G. Test Reports: Certified test reports shall be furnished for all cables.

H. Field inspection and testing will be performed under provisions of Division 1.

I. Inspect exposed cable sections for physical damage. Verify that cable is connected according to Drawings and that shield grounding, cable support, and terminations are properly installed.

J. Perform DC high potential test of each conductor, with other conductors grounded, in accordance with the manufacturer's recommendations. Apply test voltage to conductors in at least eight equal increments to maximum test voltage. Record leakage current at each increment, allowing for charging current decay. Hold maximum test voltage for ten minutes.

K. Record results of test in tabular form and in plots of current versus voltage for incremental voltage steps, and current versus time (30 second intervals) at maximum voltage. Curves shall be identified with the cable t which they apply and shall be certified. Time of day, outside temperature and humidity at time of each test shall appear on each curve sheet.

L. Perform shield continuity tests.

M. Perform phasing checks.

N. If any primary cable fails, or tests, in the opinion of the Owner, unacceptable cable defects, all cables in that conduit between the nearest pulling points on each side of the failure shall be removed. If, in the opinion of the Owner, other cables that may have been installed in the same duct are not damaged, they may be re-installed, but the failed cable shall be replaced with new cable without additional charge.

0. After replacement of the faulty cable, and any other damaged cables, all cables of the circuit in that conduit shall be re-tested. If the cable fails again, or if tests, in the opinion

of the Architect, show unacceptable cable defects, all cables shall be replaced without charge and this procedure shall be repeated until tests prove satisfactory.

3.9 CABLE IDENTIFICATION AND LABELING

A. Provide the following information on cable identification label:

1. Main feeder circuit breaker number.

2. Phase.

3. To and From Data.

B. Install cable labels on each conductor at each cable termination, each cable splice, in each manhole and in each pullbox. Additionally, at these locations, provide on inch (1") colored vinyl plastic electrical tape wrap identification, (Scotch 35 or approved equal) around each conductor and cable as follows:

1. 5 kV individual conductor system:

a. A - Phase - one (1) yellow wrap.

b. B - Phase - two (2) yellow wraps with 1/2-inch space between wraps.

c. C - Phase - three (3) yellow wraps with 1/2-inch space between wraps.

2. 5 kV multi-conductor cable system - three (3) yellow wraps with no space between wraps.

3. 15 kV individual conductor system:

a. A - Phase - one (1) red wrap.

b. B - Phase - two (2) red wraps with 1/2-inch space between wraps.

c. C - Phase - three (3) red wraps with $^{1}/$2-inch space between wraps.

4. 15 kV multi-conductor cable system - three (3) red wraps with no space between wraps.

C. See paragraph above under "Terminating and Splicing" for splice label requirements. This is in addition to identification labels.

D. During entire cable installation, phasing of conductors shall be maintained and identified. Where final connections to equipment are made, phasing shall be verified and proper phase rotation determined prior to connection.

E. Identify cables as to manufacturer, year, voltage, size, temperature, rating and ampere capacity. If such identification is not visible on the surface, the information shall be supplied on an engraved lamicoid tag permanently secured to the cable in each accessible

location.

F. Identify cables with circuit number and last and next accessible location at each substructure with an engraved lamicoid nameplate.

G. Cables shall be identified in every manhole and pullbox by voltage, circuit name, and location of next accessible point. Identification tags shall be stamped lead or engraved lamicoid nameplate, red with white letters, approximately three-inch by five-inch (3-inch x 5-inch), fastened with #12 copper wire.

3.10 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to Manufacturer and Installer, to prevent entrance of moisture into the cables and to ensure medium-voltage cables are without damage or deterioration at the time of Substantial Completion.

END OF SECTION 260527

SECTION 260528 - ELECTRICAL FIRESTOPPING

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. Section includes:

1. Through-penetration firestopping in fire rated construction.

2. Through-penetration smoke-stopping in smoke partitions.

B. Related items: Raceway seals and manufactured electrical devices: Refer to Division 26 Section, "Raceways and Boxes".

1.3 REFERENCES

A. Underwriters Laboratories

1. UL Fire Resistance Directory

a. Through-penetration firestop devices (XHCR)

b. Fire resistance rating (BXUV)

c. Through-penetration firestop systems (XHEZ)

d. Fill, void, or cavity material (XHHW)

B. American Society for Testing and Materials Standards: ASTM E 814-88: Standard Test Method for Fire Tests of Through-Penetration Firestops.

1.4 DEFINITIONS

A. Assembly: Particular arrangement of materials specific to given type of construction described or detailed in referenced documents.

B. Barriers: Time-rated fire walls, smoke barrier walls, time rated ceiling/floor assemblies and structural floors.

C. Firestopping: Methods and materials applied in penetrations and unprotected openings to

limit spread of heat, fire, gasses and smoke.

D. Penetration: Opening or foreign material passing through or into barrier or structural floor such that full thickness of rated materials is not obtained.

E. System: Specific products and applications, classified and numbered by Underwriters Laboratories, Inc. to close specific barrier penetrations.

F. Sleeve: Metal fabrication or pipe section extended through thickness of barrier and used to permanently guard penetration. Sleeves are described as part of penetrating system in other Sections and may or may not be required.

1.5 SYSTEM DESCRIPTION

A. Design Requirements

1. Fire-rated construction: Maintain barrier and structural floor fire resistance ratings including resistance to cold smoke at all penetrations, connections with other surfaces or types of construction, at separations required to permit building movement and sound or vibration absorption.

2. Smoke barrier construction: Maintain barrier and structural floor resistance to cold smoke at all penetrations, connections with other surfaces and types of construction and at all separations required to permit building movement and sound or vibration absorption.

1.6 SUBMITTALS

A. Submit in accordance with Division 1, unless otherwise indicated.

B. Product Data: Manufacturer's specifications and technical data including the following:

1. Detailed specification of construction and fabrication.

2. Manufacturer's installation instructions.

C. Shop Drawings: Indicate dimensions, description of materials and finishes, general construction, specific modifications, component connections, anchorage methods, hardware, and installation procedures, plus the following specific requirements.

1. Details of each proposed assembly identifying intended products and applicable UL system number, or UL classified devices.

2. Manufacturer or manufacturer's representative shall provide qualified engineering judgment and drawings relating to non-standard applications as needed.

D. Quality control submittals: Statement of qualifications.

E. Applicators' qualifications statement: List past projects indicating required experience.

I.7 QUALITY ASSURANCE

A. Installer's qualifications: Firm experienced in installation or application of systems similar in complexity to those required for this project, plus the following:

1. Acceptable to or licensed by manufacturer, State or local authority where applicable.

2. At least 2 years' experience with systems.

3. Successfully completed at least 5 comparable scale projects using this system.

B. Local and State regulatory requirements: Submit forms or acceptance for proposed assemblies not conforming to specific UL Firestop System numbers, or UL classified devices.

C. Materials shall have been tested to provide fire rating at least equal to that of the construction.

D. Manufacturer shall be a member of the International Firestop Council (IFC).

1.8 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:

1. Deliver products in original unopened packaging with legible manufacturer's identification.

2. Coordinate delivery with scheduled installation date, allow minimum storage at site.

B. Storage and protection: Store materials in a clean, dry, ventilated location. Protect from soiling, abuse, moisture and freezing when required. Follow manufacturer's instructions.

1.9 PROJECT CONDITIONS

A. Existing conditions:

1. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.

2. Proceed with installation only after penetrations of the substrate and supporting brackets have been installed.

B. Environmental requirements:

1. Furnish adequate ventilation if using solvent.

2. Furnish forced air ventilation during installation if required by manufacturer.

3. Keep flammable materials away from sparks or flame.

4. Provide masking and drop cloths to prevent contamination of adjacent surfaces by firestopping materials.

1.10 GUARANTEE

A. Submit copies of written guarantee agreeing to repair or replace joint sealers which fail in joint adhesion, extrusion resistance, migration resistance, or general durability or appear to deteriorate in any other manner not clearly specified by submitted manufacturer's data as an inherent quality of the material for the exposure indicated. The guarantee period shall be two years from date of substantial completion unless otherwise noted.

PART 2 - PRODUCT

2.1 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

1. Hilti

2. 3M

3. Nelson

2.2 THROUGH-PENETRATION FIRESTOPPING OF FIRE-RATED CONSTRUCTION

A. Systems of devices listed in the UL Fire Resistance Directory under categories XHCR and XHEZ may be used, providing that it conforms to the construction type, penetrate type, annular space requirements and fire rating involved in each separate instance, and that the system be symmetrical for wall applications. Systems or devices must be asbestos-free.

1. Additional requirements: Withstand the passage of cold smoke either as an inherent property of the system, or by the use of a separate product included as a part of the UL system or device, and designed to perform this function.

2. Acceptable manufacturers and products.

a. Those listed in the UL Fire Resistance directory for the UL System involved and as further defined in the "System and Applications Schedule" in Part 3 of this Section.

b. All firestopping products must be from a single manufacturer.

2.3 SMOKE-STOPPING AT SMOKE PARTITIONS

A. Through-penetration smoke-stopping: Any system complying with the requirements for through-penetration firestopping in fire-rated construction, as specified in "The

Systems and Applications Schedule" in Part 3 of this Section, is acceptable, provided that the system includes the specified smoke seal or will provide a smoke seal. The length of time of the fire resistance may be disregarded.

2.4 ACCESSORIES

A. Fill, void or cavity materials: As classified under category XHHW in the UL Fire Resistance Directory.

B. Forming materials: As classified under category XHKU in the UL Fire Resistance Directory.

C. Sleeves: Minimum 24 MSG galvanized steel, 12-inch diameter or smaller steel pipe. Sleeve shall project 'A-inch from each surface of the floor/wall. Size as recommended by firestop manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.

1. Verify barrier penetrations are properly sized and in suitable condition for application of materials.

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

3.2 PREPARATION

A. Clean surfaces to be in contact with penetration seal materials of dirt, grease, oil, loose materials, rust, or other substances that may affect proper fitting, adhesion, or the required fire resistance.

3.3 INSTALLATION

A. Install penetration seal materials in accordance with printed instructions of the UL Fire Resistance Directory and in accordance with manufacturer's instruction.

B. Seal holes or voids made by penetrations to ensure an effective smoke barrier.

C. Protect materials from damage on surfaces subject to traffic.

D. When large openings are created in walls or floors to permit installation of conduits, cable tray, or other items, close unused portions of opening with firestopping materials tested for the application.

E. Install smoke stopping as specified for firestopping.

F. Provide sleeves the full thickness of the assembly being penetrated and cut sleeves to a

length of 1-inch more than the over-all thickness of the penetration, or as recommended by the firestop manufacturer.

3.4 FIELD QUALITY CONTROL

A. Examine penetration sealed areas to ensure proper installation before concealing or enclosing areas.

B. Keep areas of work accessible until inspection by applicable code authorities.

C. Perform under this section patching and repairing of firestopping caused by cutting or penetration by other trades.

3.5 ADJUSTING AND CLEANING

A. Clean up spills of liquid components.

B. Neatly cut and trim materials as required.

C. Remove equipment, materials and debris, leaving area in undamaged, clean condition.

3.6 SYSTEMS AND APPLICATION SCHEDULES*

PENETRATING ITEM	CONCRETE	GYPSUM	WOOD FLOOR/CEILING
Metal Pipe	CAJI001 CP25S/L, CP25N/S	WLI001 CP 25	FC1002 CP 25
	CAJI006 CS-195+, FS-I95+	WL1002 FS-I95+	FC1003 2000,2000+,20003
	CAJI007 FS-195+, 1-inch& 2-inch Wide	WL1003 CP 25WB+,CP 25N/S	FC1006 CP 25WB+
	CAJ1009 2000, 2000+, 2003	WL1008 2000+	
	CAJ1010 2000, 2000+, 2003	WL1009 2000+	
	CAJ10 I 22000, 2000+, 2003	WLIO I 0 2000+	
	CAJI0I3 2000, 2000+, 2003	WL1016 CP 25WB+	
	CAJI014 2000, 2000+, 2003	WL1017 CP 25WB+,CP 25N/S	
	CAJ1015 2000, 2000+, 2003	WL1032 CP 25WB+,CP 25N/S	
	CAJ1017 FD 150	WL1036 FD 150	
	CAJ1021 FD 150	WI-1037 CS-195+,FS-195+	
	CAJ1027 MPS-2+	WL1067 CP 25N/S	
	CAJI044 CP 25WB+	WL1073 CP 25WB+	
	CAJ1052 CP 25S/L, CP 25N/S	WL1080 MPS-2+	
	CAJ1058 2000, 2000+, 2003	WL1082 2000+	
	CAJ1060 2000, 2000+, 2003		
	CM1063 2000, 2000+, 2003		
	CM1066 CP 25N/S,CP 25S/L, CP 25WB+		
	CM1091 CP 25N/S,CP 25S/L, CP 25WB+		
	CAJ1092 CP 25WB+		
	CAJ1112 FS-195+		
	CM 1160 CP 25S/L, CP 25N/S		
	CAJ1175 CP 25WB+		
	CAJ1176 CP 25WB+		
	CAJI 188 2000+		
	CBJ1020 CS-I95+, FS-195+		
	CBJ1021 CS-195+, MPS-2+		
	CBJ10312001 CBJ10322001		
	FA1002 CP 25WB+		
	W11010 CP 25WB+ WJ1023 2001		

PENETRATING ITEM	CONCRETE	GYPSUM	WOOD FLOOR/CEILING
Non-Metallic	CAJ2001 FS-195+, 1-inch& 2-inch WIDE, PPD'S CAJ2002 FS-195+ CAJ2003 CS-195+, FS-195+ CAJ2005 FS-195+ CAJ2006 FS-195+ CAJ2013 FS-195+ CAJ2019 2000, 2000+, 2003 CAJ2027 FS-195+, CP 25N/S, CP 25S/L, CP 25WB+ CAJ2028 FS-195, MPS-2+ CAJ2029 FS-195+, PPD'S CAJ2030 CS-195+, FS-195+ CAJ2040 FS-195+, CP 25WB+ CAJ2044 FS-195+, CP 25N/S, CP 25S/L CP 25 WB+ CAJ2090 FS-195+ CA12177 FS-195+, PPD'S FA2001 FS-195+, PPD'S FS2002 CS-195+, FS-195+, MPS-2+,	WL2002 FS-195+, PPD'S WL2003 FS-195+ WL2004 FS-195+ WL2005 FS-195+4' WIDE WL2006 FS-195+ WL2013 FS-195+ WL2031 CS-195+, FS-195+ WL2032 CS-195+, FS-195+ WL2033 FS-195+ WL2073 FS-195+ I-inch WIDE	FC2002 FS-195+, PPD'S FC2007 FS-195+, PPD'S FC2008 FS-195+ FC2009 FS-195+, PPD'S FC2024 FS-195+ FC2026 FS-195+ FC2028 FS-195+, l' & 2-inch WIDE, PPD'S
Insulated Cable	CAJ3001 CP 25N/S, CP 25S/L CAJ3005 CS 195+, FS-195+ CAJ3007 2001 CAJ3009 2000, 2000+, 2003 CAJ3010 2000, 2000+, 2003 CAJ3011 2001 CAJ3014 FD 150 CAJ3015 FD 150 CAJ3021 MPS-2+ CAJ3029 2000, 2000-F, 2003 CAJ3030 CP 25WB+ CAJ303I CP 25N/S, CP 25S/L CAJ3041 2000, 2000+, 2003 CA13044 CS-195+, FS-195+ CAJ3058 FS-195+, MPS-2+ CAJ3071 CP 25N/S, CP 25S/L CAJ3074 CP 25N/S, CP 25S/L CAJ3075 2001 CAJ3080 CP 25WB+ CBJ3016 CS- 195+, FS-195+ CBJ3017 CS-195+, MPS-2+ FA3001 CP 25WB+ FB3004 CS-195+, MP WJ3015 2001 WJ3016 2001	WL3001 CP 25, MPS-2+ WL3008 2000+ WL3009 2000+ WL3015 CP 25WB+, CP 25N/S WL3022 2000+ WL3030 FS-195+ WL3031 MPS-2+ WL3032 CP 25WB+ WL3041 2000+ WL3051 CP 25N/S WL3056 CP25N/S WL3062 CP 25WB+	FC3001 CP 25S/L, CP 25N/S FC3002 2000+ FC3003 2000, 2000+, 20003 FC3007 CP 25WB+, MPS-2+ FC3008 FS-195+

Mixed Penetrating Items Combos	CA18001 CS-195+ FS-195+ CAJ8003 2000, 2000+, 20003 CAJ8004 2000, 2000+, 20003 CAJ8006 2001 CAJ8013 FS-195+, CP 25	WL8002 CS-195+, FS-1954	
	CBJ8004 CBJ8005 CBJ8008 FA800I	CS-195, FS-195+ CS-195+, MPS-2+ 2001 FS-I95+, CP 25WB+	

* Underwriter's Laboratories, Inc., Fire Resistance Directory.

END OF SECTION 260528

SECTION 260529 - HANGERS AND SUPPORTS

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.

B. Requirements of the following Division 26 Sections apply to this Section:

1. Division 26 Section, "Common Work Results for Electrical".

1.2 SUMMARY

A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 5 Section, "Metal Fabrications" - for requirements for miscellaneous metal items involved in supports and fastenings.

2. Division 7 Section, "Penetration Firestopping" - for requirements for firestopping at sleeves through walls and floors that are fire barriers.

3. Refer to other Division 26 Sections for additional specific support requirements that may be applicable to specific items.

C. Provide equipment supports consisting of platforms, curbs, concrete pads, gratings, cradles, structural members, hangers, rods, racks, and incidental materials.

D. Provide all labor, supervision, and fabrication. Design and construct supporting structures of strength to safely withstand stresses to which they may be subjected and to properly distribute the load and impact over building areas. Provide all engineering and fabrication as required for installation of support system.

E. Provide hangers, clamps, anchors, inserts, supports, supplementary steel framing, and hardware of the proper size and load capacity to support electrical equipment and raceways, whether indicated on the drawings or not.

1.3 SUBMITTALS

A. General: Submit the following in accordance with conditions of Contract and Division I Specification Sections.

B. Product data for each type of product specified.

C. Submit for review, shop/assembly drawings and layout drawings of curbs and equipment supports for major items of equipment.

D. Submit structural calculations for approval. Calculations include stress and deflection analysis. Submit design criteria and selection calculation.

E. Supporting devices and fastening methods shall be subject to the review and approval of the Structural Engineer.

1.4 QUALITY ASSURANCE

A. Electrical Component Standard: Components and installation shall comply with NFPA 70 *National Electrical Code.*

B. Electrical components shall be listed and labeled by UL, ETL, CSA, or other approved, nationally recognized testing and listing agency that provides third-party Certification follow-up services.

C. Installation Standard: Installation shall meet or exceed the National Electrical Contractors Association (NECA) Standard of Installation.

D. Manufacturer's Qualifications:

1. The Manufacturer shall not have had less than ten years' experience in manufacturing Strut Support Systems.

2. The Manufacturer must certify in writing all components supplied have been produced in accordance with an established quality assurance program.

E. Installer's Qualifications:

1. Installer must be a factory-trained manufacturer's authorized representative/installer with not less than five years’ experience in the installation of Strut Support Systems of this size and conformation.

2. All Strut Support System components must be supplied by a single manufacturer.

F. Standards:

1. Work shall meet the requirements of the following standards:

a. Federal, State and Local Codes.

b. American Iron and Steel Institute (AISI) Specification for the Design of Cold-Formed Steel Structural Members - August 19, 1986 Edition, December 1, 1989 Addendum.

c. American Society for Testing and Materials (ASTM).

d. Underwriters Laboratories (UL).

e. National Electrical Code (NEC).

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. All material is to be delivered to the work site in original factory packaging to avoid damage to the finish.

B. Upon delivery to the work site, all components shall be protected from the elements by a shelter or other covering.

1.6 GUARANTEE

A. Separate guarantees shall be issued from the erector and manufacturer, valid for a period of one year against any defects that may arise from the installation or manufacture of the Strut Support System components.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

1. Slotted Metal Angle and U-Channel Systems:

a. American Electric, Kindorf

b. Alstrut

c. Unistrut Diversified Products

d. Power-Strut

e. Thomas & Betts

2. Conduit Sealing Bushings and Accessories:

a. Bridgeport Fittings, Inc.

b. GS Metals Corporation

c. O-Z/Gedney

d. Raco, Inc.

2.2 COATINGS

A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion-resistance using approved alternative treatment, finish, or inherent material characteristic. All products shall be hot-dip galvanized.

2.3 MANUFACTURED SUPPORTING DEVICES

A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.

B. Fasteners: Types, materials, and construction features, as follows:

1. Expansion Anchors - Carbon steel wedge or sleeve type.

2. Toggle Bolts - All steel springhead type.

3. Power-Driven Threaded Studs - Heat-treated steel, designed specifically for the intended application.

C. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.

D. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.

E. U-Channel Systems: Sixteen-gauge channels with 9/16-inch-diameter holes at a minimum of eight inches on center in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacturer.

F. Concrete Equipment Pads:

1. Refer to Division 26 Section, "Common Work Results for Electrical" for installation requirements.

G. Floor-Mounted Stands: Construct with structural steel members or steel pipe and fasten with flanges bolted to the floor.

H. Ceiling Suspended Platforms: Construct with steel hangers. Brace and fasten to building structure.

I. Wall-Mounted Platforms: Construct with steel brackets.

2.4 ANCHOR METHODS

A. Hollow Masonry: Toggle bolts or plastic conical type expansion anchors.

B. Solid Masonry: Lead expansion anchors or preset inserts.

C. Metal Surfaces: Machine screws, bolts, or welded studs.

D. Wood Surfaces: Wood screws.

E. Concrete Surfaces: Self-drilling anchors or power-driven studs (non-seismic zones) (Female wedge, stud wedge, or undercut drill-in bolt anchors (seismic zones).

2.5 VIBRATION ISOLATION MOUNT TYPES

A. Type DNP (Double Neoprene Pad)

1. Neoprene pad isolators shall be formed by two layers of 'h-inch to 1/16-inch thick ribbed or waffled neoprene, separated by a stainless steel or aluminum plate. Layers shall be permanently adhered together. Pads shall be sized so that they will be loaded within the manufacturer's recommended range.

2. Type DNP isolators shall be formed from one of the following products or approved equal:

a. Type NR: Amber/Booth.

b. Type Korpad: Korfund Dynamics.

c. Type WSW: Mason Industries.

d. Type NPS: Peabody Noise Control.

e. Series Shear Flex: Vibration Mountings and Control.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The installer shall inspect the work area prior to installation. If work area conditions are unsatisfactory, installation shall not proceed until satisfactory corrections are completed.

3.2 INSTALLATION

A. Installation shall be accomplished by a fully trained manufacturer-authorized installer.

B. Set Strut System components into final position true to line, level and plumb, in accordance with approved Shop Drawings.

C. Anchor material firmly in place. Tighten all connections to their recommended torques.

D. Install supporting devices to fasten electrical components securely and permanently in

accordance with NEC requirements.

E. Coordinate with the building structural system and with other electrical installation.

F. Raceway Supports: Comply with the NEC and the following requirements:

1. Conform to manufacturer's recommendations for selection and installation of supports.

2. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 pounds, provide additional strength until there is a minimum of 200 pounds safety allowance in the strength of each support.

3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.

4. Support parallel runs of horizontal raceways together on trapeze-type hangers.

5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4-inch-diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.

6. Space supports for raceways in accordance with NFPA-70.

7. Support exposed and concealed raceway within one foot of an unsupported box and access fittings. In horizontal runs, support at the box and access fittings may be omitted where box or access fittings are independently supported and raceway terminations are not made with chase nipples or threadless box connectors.

8. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminations.

G. Miscellaneous Supports: Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting disconnects, light fixtures, and other devices.

H. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support; support sheet metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to the raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box.

I. Sleeves: Install in concrete slabs and walls and all other fire-rated walls for raceways and

cable installations. For sleeves through fire rated-wall construction, apply UL-listed firestopping sealant in gaps between sleeves and enclosed conduits and cables in accordance with "Fire Resistant Joint Sealers" requirement of Division 7 Section, "Joint Sealers".

J. Conduit Seals: Install water tight seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.

K. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including, but not limited to conduits, raceways, boxes, disconnect switches, and control components in accordance with the following:

1. Fasten by means of toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine screws. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures.

2. Holes cut to depth of more than 1-1/2 inches in reinforced concrete beams or to depth of more than 3/4-inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.

3. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration-and shock-resistant fasteners for attachments to concrete slabs.

4. Concrete (New): Iron or steel inserts. Expander type anchors, specified for existing may be used provided concrete is clear of conduit for drilled depth.

5. Concrete (Existing): Double-plated expander type anchors. Phillips, Hilti, or approved equivalent. Loads shall not exceed 1/4 of tested pullout (or shear) strength.

6. Precast Concrete Plank: Drill hole through plank; bolt hanger rod to 4 x 4 x 1/8 steel plate on top of plank.

L. Tests: Test pull-out resistance of one of each type, size, and anchorage material for the following fastener types:

1. Expansion anchors.

2. Toggle bolts.

3. Power-driven threaded studs.

M. Provide all jacks, jigs, fixtures, and calibrated indicating scales required for reliable testing. Obtain the structural Engineer's approval before transmitting loads to the structure. Test to 90 percent of rated proof load for fastener. If fastening fails test, revise

all similar fastener installations and retest until satisfactory results are achieved.

N. General Supporting Installations:

1. Provide appropriate concrete anchors for hanger rods. Rods shall be screwed into or extended through frame construction (with washer and nut). Supports shall secure conduit in place, and shall prevent vibration, provide for expansion and contraction and shall make neat appearance. Strap hangers or chains are not permitted.

2. Electrical raceways (conduit and EMT) 1-1/2-inches and smaller shall be secured with 1-hole malleable iron straps or brackets to walls. Trapeze supports shall be used for groups or parallel raceways with raceways secured to trapeze with approved clamps. Individual runs of raceways 2-inches and larger shall be supported by Clevis type hangers.

3. Provide all steel supports including roof curbs for all equipment provided under this Section.

4. Electrical raceway supports to be spaced on the following maximum centers:

   a. [Y2-inch] [3/4-inch] to 1-inch conduit - 8 feet

   b. [1-1/4-inch and larger - 10 feet]

5. Provide additional hangers or steel members to distribute the load among two or more structural members when required or directed.

6. Drilling of new concrete slabs will not be permitted. Anchors and inserts shall be cast in the concrete slabs.

0. Locations:

1. Anchor bolts, sleeves, inserts, hangers, and supports required for the electrical work shall be furnished and installed under Division 26.

2. Coordinate with other trades the location of anchors, sleeves, inserts, and supports and insure that they are properly installed.

3. Openings and sleeves shall be set true to line, level, plumb, and position and shall be so maintained during construction. Where sleeves and openings are provided in poured concrete, inspect same during and after concrete is poured to insure proper position and correct any deviation.

P. Hangers and Supports:

1. Provide hangers, angles, channels, and other supports required by field conditions to install items of electrical equipment. Design of supports and methods of fastening to building structure shall be acceptable to the Owner.

2. Use of power-actuated fasteners and devices is permitted in the vertical surfaces of the building only with the following requirements.

    a. For fastening conduits 1-1/2-inch and smaller and lighting fixtures 50 lbs or less.

    b. Load capacity per manufacturer's recommendations.

    c. Fasteners shall be located in the thickest part of the slab.

    d. Devices shall comply with OSHA requirements.

3. Use of lead shield expansion anchors is not permitted.

4. No electrical items shall rest on, or depend for support on suspended ceiling media (tiles, lath, plaster, splines, etc.).

5. In suspended ceilings, support conduits directly from structural slabs, decks (or framing members). Do not support conduits on ceiling suspension members.

6. Support surface or pendant lighting fixtures:

    a. From an outlet box by means of an interposed metal strap, where weight is less than 5 lbs.

    b. From an outlet box by means of a hickey or other direct threaded connection, where weight is from 5 to 50 lbs.

    c. Directly from structural slab, deck or framing member, where weight exceeds 50 lbs.

7. In addition to the above, provide cushioned, swivel type hangers with appropriate outlet boxes for pendant fixtures in mechanical areas. Such hangers shall have a support rating at least twice that of the load supported.

8. Support recessed lighting fixtures:

    a. From ceiling suspension members, where weight is less than 60 lbs.

    b. Directly from structural slab, deck, or framing members, where weight is 60 lbs. or more.

9. Provide weight-distribution facilities, where required so as not to exceed the load bearing capabilities of floor or walls that bear the weight of, or support, electrical items.

10. For point-of-attachment weight of 100 lbs. or less, fasten items as follows:

    a. On wood, use wood screws.

b. On concrete and solid masonry that is already in place, use self-drilling concrete anchors or expansion bolt and couplings.

c. On hollow construction, use toggle bolts.

d. On structural steel, use beam clamps.

11. For point-of-attachment weights from 100 lbs. to 300 lbs., provide supports as follows:

a. At cast-in-place concrete slabs, use concrete inserts in bottom of slab, with 8" slip-through steel rods set transverse to the reinforcing steel.

b. At concrete slab already in place, uses 16-inches x 8-inches x $^{1}/2$-inch steel plates at the top of the slab, with through-bolts welded in place. The plates shall be chased in and grouted flush, where no fill is to be applied.

12. For point-of-attachment weights over 300 lbs., provide supports as follows: At cast-in-place concrete slabs, uses 16-inch x 8-inch x$^{1}/2$-inch steel plate, with through bolts welded in place. Top of the plate shall be 1-1/2-inches below the top of the slab, or on top of the slab where a fill slab is to be installed.

13. Hangers and supports shall be hot dipped galvanized, unless noted otherwise.

14. Equipment shall not be held in place by its own dead weight. Provide base anchor fasteners in each case.

15. Trapeze type hangers may be used where several conduits are to be installed at the same elevation. The spacing of such trapeze hangers shall be in accordance with the NEC for the smallest conduit in the run.

16. Vertical conduits shall be supported by heavy wrought iron clamps or collars anchored to construction at each floor.

Q. Inserts:

1. Inserts for suspended items in poured concrete construction shall be malleable-iron concrete inserts, adjustable type with insert nut.

2. Items manufactured by Barrett, Crawford, Elcen, or Grinnell shall be used where applicable.

3. Inserts for surface-mounted items shall be suitable for the composition of the slab, wall, or structure on which installation is to be made.

R. TABLE 1: SPACING FOR RACEWAY SUPPORTS

TABLE 1: SPACING FOR RACEWAY SUPPORTS

Raceway Size (Inches)	No. of Conductors in Run	Location	RNC & IMC (Ft.)	EMT (Ft.)
		HORIZONTAL RUNS		
1/2, ¾	1 or 2	Flat ceiling or wall.	5	5
1/2, ¾	1 or 2	Where it is difficult to provide supports except at intervals fixed by the building construction.	7	7
1/2, ¾	3 or more	Any location.	7	7
1/2 – 1	3 or more	Any location.		
1 & larger	1 or 2	Flat ceiling or wall.	6	6
1 & larger	1 or more	Where it is difficult to provide supports except at intervals fixed by the building construction.	10	10
1 & larger	3 or more	Any location.	10	10
Any	---	Concealed.	10	10
		VERTICAL RUNS		
1/2, ¾	---	Exposed.	7	7
1, 1-1/4	---	Exposed.	8	8
1-1/2 & larger	---	Exposed.	10	10
Up to 2	---	Shaftway.	14	10
2-1/2	---	Shaftway.	16	10
3 & larger	---	Shaftway.	20	10
Any	---	Concealed.	10	10
Abbreviations:	EMT	Electrical Metallic Tubing		
	IMC	[Intermediate Metallic Conduit]		
	RNC	[Rigid Nonmetallic Conduit]		
	RGS	[Rigid Galvanized Steel]		

	G R S P V C	[PVC Coated Galvanized Rigid Steel]

3.3 CLEANUP

A. Upon completion of this section of work, remove all protective wraps and debris. Repair any damage due to installation of this section of work.

3.4 PROTECTION

A. During installation, protect this work from damage.

B. Upon completion of this scope of work, it shall become the responsibility of the General Contractor to protect this work from damage during the remainder of construction on the project and until substantial completion.

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES

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 raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1. Raceways include the following:

a. EMT.

b. ENT.

c. FMC.

d. IMC.

e. LFMC.

f. LFNC.

g. PVC.

h. PVC externally coated, IMC.

i. PVC externally coated, rigid steel conduits.

j. RGS.

k. RMC.

1. Surface raceways.

m. Wireways.

2. Boxes, enclosures, and cabinets include the following:

a. Device boxes.

b. Floor boxes.

c. Outlet boxes.

d. Pull and junction boxes.

e. Cabinets and hinged-cover enclosures.

3. Miscellaneous Products include the following:

a. Expansion/Deflection fittings.

b. Bushings.

B. Related Sections include the following:

1. Division 26 Section, "Electrical Firestopping"

2. Division 26 Section, "Hangers and Supports" for raceways and box supports.

3. Division 26 Section, "Wiring Devices" for devices installed in boxes and for floor-box service fittings.

4. Division 27 Section, "Technology" for data, communication, CCTV devices, jacks and cabling.

1.3 DEFINITIONS

A. EMT: Electrical Metallic Tubing.

B. FMC: Flexible Metal Conduit.

C. IMC: Intermediate Metal Conduit.

D. LFMC: Liquidtight Flexible Metal Conduit.

E. PVC: Rigid Polyvinyl Chloride Conduit.

F. RGS: Rigid Galvanized Steel Conduit.

G. RMC: Rigid Metal Conduit.

H. RNC: Rigid Nonmetallic Conduit.

1.4 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: Include layout drawings showing components and wiring for nonstandard boxes, enclosures, and cabinets.

1.5 QUALITY ASSURANCE

A. Listing and Labeling: Provide raceways and boxes specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100

2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

B. Comply with NECA's "Standard of Installation" and NECA 101 "Recommended Practice for Installing Steel Conduits".

C. Comply with NFPA 70.

1.6 COORDINATION

A. Contractor to furnish and install all labor and material for the installation of the conduits, raceways, outlet boxes, backboxes, and sleeves for the communication systems and other required systems including intercom system.

B. Coordinate conduit raceways, outlet boxes, backboxes, and sleeves with the Communication Contractor.

C. Install direct burial fiber cable, telephone cable and outside plant cable in conduit/ductbanks.

D. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

E. Verify routing and termination locations of conduits and boxes prior to rough-in.

F. Conduit routing shown on Drawings is only approximate and diagrammatic. Route conduits as required for a complete conduit and wiring system.

G. Coordinate installation of outlet boxes, mounting heights, orientation, and locations of outlets.

H. It is the Electrical Contractor's responsibility to provide the following:

1. All labor and material for the installation of conduits, raceways, sleeves, etc., with pull cords at locations indicated on the drawings.

2. Coordinate with Technology Contractor for locations of all conduits, penetrations and sleeves for all systems within that section.

1.7 PROJECT RECORD DOCUMENTS:

A. Accurately record routing of all concealed conduits and cables. Record actual routing of all exposed conduits/larger than 1 inch. Indicate actual locations and mounting heights of outlet boxes, pull and junction boxes, branch circuits, arrangements, etc.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Metal Conduit and Tubing:

a. Allied Tube & Conduit Corporation.

b. Anamet, Inc.; Anaconda Metal Hose.

c. AFC/Monogram Company.

d. Carol Cable Co., Inc.

e. Cole-Flex Corp.

f. Electri-Flex Co.

g. Flexcon, Inc.; Coleman Cable Systems, Inc.

h. Grinnell Co.; Allied Tube and Conduit Div.

i. Monogram Co.; AFC.

j Spiraduct, Inc.

k. Triangle PWC, Inc.

1. Wheatland Tube Co.

2. Nonmetallic Conduit and Tubing:

a. Anamet, Inc.; Anaconda Metal Hose.

b. Arnco Corp.

c. Breeze-Illinois, Inc.

d. Cantex Industries; Harsco Corp.

e. Certainteed Corp.; Pipe & Plastics Group.

f. Cole-Flex Corp.

g. Condux International; Electrical Products.

h. Electri-Flex Co.

i. George-Ingraham Corp.

j. Hubbell, Inc.; Raco, Inc.

k. Lamson & Sessions; Carlon Electrical Products.

l. R&G Sloan Manufacturing Co., Inc.

m. Spiraduct, Inc.

n. Thomas & Betts Corp. I

3. Conduit Bodies and Fittings:

a. American Electric; Construction Materials Group.

b. Crouse-Hinds; Div. of Cooper Industries.

c. Emerson Electric Co.; Appleton Electric Co.

d. Hubbell, Inc.; Killark Electric Manufacturing Co.

e. Lamson & Sessions; Carlon Electrical Products.

f. O-ZlGedney; Unit of General Signal.

g. Scott Fetzer Co.; Adalet-PLM.

h. Spring City Electrical Manufacturing Co.

i. Thomas & Betts Corporation.

4. Metal Wireways:

a. Hoffman Engineering Co.

b. Keystone/Rees, Inc.

c. Square D Co.

5. Nonmetallic Wireways:

a. Hoffman Engineering Co.

b. Lamson & Sessions; Carton Electrical Products.

c. Wiremold Co.

d. Hubbell

6. Surface Metal Raceways:

a. Airey-Thompson Co., Inc.; A-T Power Systems.

b. American Electric; Construction Materials Group.

c. Butler Manufacturing Co.; Walker Division.

d. Wiremold Co.

7. Surface Nonmetallic Raceways:

a. Anixter Brothers, Inc.

b. Butler Manufacturing Co.; Walker Division.

c. Hubbell, Inc.; Wiring Device Division.

d. JBC Enterprises, Inc.; Enduro Fiberglass Systems.

e. Lamson & Sessions; Carlon Electrical Products.

f. Panduit Corp.

g. Thermotools Co.

h. United Telecom; Premier Telecom Products, Inc.

i. Wiremold Co.

8. Boxes, Enclosures, and Cabinets:

a. American Electric; FL Industries.

b. Butler Manufacturing Co.; Walker Division.

c. Crouse-Hinds; Div. of Cooper Industries.

d. Electric Panelboard Co., Inc.

e. Erickson Electrical Equipment Co.

f. Hoffman Engineering Co.; Federal-Hoffman, Inc.

g. Hubbell Inc.; Killark Electric Manufacturing Co.

h. Hubbell Inc.; Raco, Inc.

i. Lamson & Sessions; Carlon Electrical Products.

j. O-Z/Gedney; Unit of General Signal.

k. Parker Electrical Manufacturing Co.

1. Robroy Industries, Inc.; Electrical Division.

m. Scott Fetzer Co.; Adalet-PLM.

n. Spring City Electrical Manufacturing Co.

o. Thomas & Betts Corp.

p. Woodhead Industries, Inc.; Daniel Woodhead Co.

9. Floor Boxes:

a. Wiremold, RFB Series.

b. Hubbell.

c. Crouse Hinds.

d. Square D.

2.2 METAL CONDUIT AND TUBING

A. Rigid Galvanized Steel Conduit: ANSI C80.1 and UL 6.

B. IMC: ANSI C80.6.

C. Plastic-Coated Steel Conduit and Fittings: NEMA RN 1.

D. Plastic-Coated IMC and Fittings: NEMA RN 1.

E. EMT and Fittings: ANSI C80.3, galvanized tubing.

1. Fittings: Compression type, NEMA FB1.

F. FMC: Zinc-coated steel.

G. LFMC: Flexible steel conduit with PVC jacket.

H. Fittings: NEMA FB 1; compatible with conduit/tubing materials.

2.3 NONMETALLIC CONDUIT AND TUBING

A. ENT: NEMA TC 13.

B. PVC: NEMA TC 2, Schedule 40 or 80.

C. ENT and PVC Fittings: NEMA TC 3; match to conduit or conduit/tubing type and material.

D. LFNC: UL 1660.

2.4 METAL WIREWAYS

A. Material: Sheet metal sized and shaped as indicated.

B. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

C. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

D. Wireway Covers: Screw-cover type.

E. Finish: Manufacturer's standard enamel finish.

2.5 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating.

B. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

2.6 OUTLET AND DEVICE BOXES

A. Sheet Metal Boxes: NEMA OS I, galvanized flat-rolled sheet steel.

B. Cast-Metal Boxes: NEMA FB I. Type FD, cast box, deep type, with gasketed cover, and threaded hubs.

C. Outlet Box Accessories: Provide outlet box accessories as required for each installation, including corrosion-resistant screws, mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps, and metal straps for supporting outlet boxes which are compatible with outlet boxes being used and fulfilling requirements of individual wiring situations.

D. Nonmetallic: NEMA 0S2.

2.7 FLOOR BOXES

A. Floor Boxes: Cast iron for at-grade or basement levels and formed steel at all above grade levels unless otherwise noted on the drawings, fully adjustable, rectangular with internal tunnel compartment. All boxes and covers shall be UL listed for protection

against scrub water.

2.8 PULL AND JUNCTION BOXES

A. Small Sheet Metal Boxes: NEMA OS 1.

B. Sheet metal boxes over 12" in any dimension shall comply with the requirements of this Section, Article "Enclosures and Cabinets", of this Section.

C. Boxes for Outdoor and Wet Locations: Flat flanged, surface-mounted, UL listed as raintight, galvanized cast iron box and cover with neoprene gasket and stainless steel cover screws.

D. Boxes for Buried Flush Grade Locations: NEMA 250, Type 6, flat flanged, UL listed as watertight, galvanized cast iron, aluminum or PVC box.

1. Cover: Nonskid cover with neoprene gasket and stainless steel cover screws.

2. Cover Legend: "Electric" or "Communications" as appropriate.

2.9 BOX EXTENSIONS

A. Prohibited on new construction.

B. Where more than one box is needed to flush out installation, provide a large (i.e., 6" x 6") box to flush out the existing box and nipple over to a new box.

2.10 ENCLOSURES AND CABINETS

A. Hinged-Cover Enclosures: NEMA 250, Type 1 in dry locations, and Type 4 in wet or damp locations, with continuous hinge cover and flush latch.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

B. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage, and include accessory feet where required for freestanding equipment.

2.11 EXPANSION / DEFLECTION FITTINGS

A. Provide an expansion/deflection fitting in each concealed or exposed electrical run crossing a building expansion joint. Fittings shall be complete with bronze end couplings, neoprene sleeves, tinned copper braid integral bonding jumper and stainless steel bands. Expansion/deflection fittings shall be suitable for the size and type of conduit run they connect. Bonding jumper shall comply with NEC and UL requirements.

B. Expansion/deflection fitting shall accommodate the following movements without

collapsing or fracturing the conduit and damaging the wires it contains:

1. Axial expansion or contraction up to 3/4-inch.

2. Angular misalignment of the axes of the conduits up to 30 degrees in all directions.

3. Parallel misalignment of the axes of the conduits up to 3/4-inch in all directions.

C. Expansion/Deflection fitting shall be OZ/Gedney Type "DX" or approved equal by Crouse Hinds (Type XD).

2.12 BUSHINGS

A. Bushings for 1-inch conduit and smaller shall be self-extinguishing thermoplastic type - 150°C temperature rating.

B. Bushings for 1-1/4" conduit and larger shall be malleable iron body with 150 degrees C insulating ring. Insulating material shall be locked in place and non-removable.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 RACEWAY REQUIREMENTS

A. Conduit:

Application	Conduit Type	Remarks
In or under concrete slab	RGS	
Exposed exterior locations.	RGS	Use threaded or rain-tight fittings.

Wet interior locations.	RGS	Use threaded or rain-tight fittings.
Exposed dry interior locations up to 7'-0" AFF.	RGS	
Exposed dry interior locations above 7'-0" AFF.	EMT	
Exterior Underground	RNC (Sched. 40 PVC)	RGS Elbows/Sweeps
Equipment connections in dry interior locations.	FMC (e.g. Greenfield)	Short lengths only (maximum 6 feet).
Equipment connections in wet interior locations.	LFMC (e.g. Sealtite)	Short lengths only (maximum 6 feet). Use threaded or rain-tight
Equipment connections in exterior locations.	LFMC (e.g Sealtite)	Short lengths only (maximum 6 feet). Use threaded or rain-tight
Concealed in dry wall construction.	EMT, IMC, RGS	
Concealed above suspended ceilings.	EMT, IMC, RGS	
Concealed in masonry walls.	EMT	

1. Provide hot-dip Rigid Galvanized Steel Conduit (RGS) for medium voltage applications, and for embedded interior work in concrete, and for 2-1/2 inch size and larger.

2. For 2-1/2 inch size and larger use RGS, IMC, EMT.

3. Provide hot-dip Rigid Galvanized Steel Conduit (RGS), galvanized intermediate Metal Conduit (IMC) or galvanized Electrical Metallic Tubing (EMT) for concealed work above suspended ceilings and within interior partitions and for exposed interior work above 7'-0". Maximum EMT size permitted is two inches.

4. Provide Flexible Metal Conduit (FMC), e.g. Greenfield, in short lengths (maximum 6 feet) for the connection for lighting fixtures, dry type transformers and any vibrating equipment. The flexible connections to recessed fixtures and equipment shall have sufficient slack to permit removal of fixture.

5. Provide Liquidtight Flexible Metal Conduit (LFMC), e.g. Sealtite, in short length (maximum 6 feet) for the connection of exterior equipment, motors and equipment in damp or wet locations as defined in Division 26 Section "Common Work Results for Electrical".

6. Provide hot-dip Rigid Galvanized Steel Conduit (RGS) with bonded PVC jacket (Plastic-Bond or Kor-Kap) for work not completely encased in concrete but laid directly in or in contact with ground or on a vapor barrier and additionally, as directed.

7. Aluminum conduit is prohibited.

8. Where indicated on the drawings, Rigid Non-metallic Conduit may be used as permitted in Article 347 of the NEC, with or without concrete encasement. Where rigid non-metallic conduit is exposed, it shall be Schedule 40 PVC, with all provisions for thermal expansion/contraction as recommended by the Manufacturer.

9. Conduits for exterior underground electric work shall be rigid steel, galvanized and sherardized, leaving the building and to points 5 feet beyond footings. Beyond 5 feet of building, underground conduits shall be non-metallic Schedule 40 PVC plastic, Type II.

10. PVC conduits for electric and telephone services shall be encased in 3 in. concrete envelope. Conduits shall be rigid same as above and beyond 5 feet of the building shall be non-metallic PVC equal to Carlon Type EB encased in concrete.

11. All steel conduits from outside terminations to service entrance equipment shall be painted with two heavy coats of asphaltum.

12. Conduits shall slope from entrance equipment toward outside of building.

13. Rigid Polyvinyl Chloride (PVC) Conduit may be used underground and under slabs except where rigid metal conduit is required.

B. Fittings:

1. All fittings to match conduit material and to be suitable for the purpose intended. Join conduit with fittings designed and approved for the purpose and make joints tight.

2. Provide UL listed compound filled sealing fittings for NEC-required locations, for conduits passing from interior to exterior, and at the interface of widely different space temperatures such as refrigeration or cold storage rooms where conduits pass from warm locations to cool locations, such as the boundaries of air conditioned spaces and non-conditioned air spaces. For concealed conduits, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces.

3. Provide expansion fittings with bonding jumpers where conduits cross expansion joints or where otherwise required to compensate for thermal expansion and contraction. Provide expansion fittings in each straight uninterrupted run of surface-mounted conduit, both horizontal and vertical, in excess of 200 feet. Distance between fittings shall not exceed 200 linear feet. The Contractor shall refer to the Architectural Drawings for expansion joint locations.

4. Fasten rigid steel conduit with threaded galvanized steel fittings, double locknuts and insulated bushings. Insulated bushings shall be OZ/Gedney type "B", or

equal.

5. Fasten EMT conduit with "Concretight" or "Raintight" compression fittings made from galvanized steel or malleable iron. Fittings using set screw or indentations as a means of attachment or made from cast "white metal" are prohibited. All connectors shall have insulated throats.

6. Fasten liquid-tight conduit with fittings incorporating a threaded ferrule, nylon sealing ring, and steel or malleable iron compression nut and body. Furnish Crouse Hinds metallic liquid-tight fittings, or equal.

7. Fasten Flexible Metallic Conduit (FMC) with Thomas & Betts (T&B) "Tite-Bite" insulated connectors, or equal.

8. Watertight fittings shall use a copper base anti-corrosive conductive compound. Provide watertight fittings in conduits exposed to weather, in wet locations, in underground locations, and in slabs.

C. Box Locations:

1. Electrical boxes shall accommodate wire pulling, splices, taps, equipment connections and Code compliance.

2. Coordinate access doors as required to provide access to boxes in hard ceilings and similar inaccessible areas.

3. Provide cast box (with threaded hubs) in exterior enclosures and high traffic areas (surface installations), as specified by Owner.

D. Outlet Boxes:

1. Outlet boxes for concealed work shall be zinc-coated or cadmium-plated sheet steel boxes suitable for the service and type outlet. Boxes and conduit fittings for outdoor and exposed work shall be NEMA 4 cast-aluminum, cast steel or cast iron type with threaded hubs for conduit entrance. Boxes and conduit fittings for outdoor work shall have gasketed cover plates. Extra large boxes shall be provided in accordance with the National Electrical Code where necessary to prevent crowding of wire in the box. Plastic boxes and cast "white metal" boxes classified as NEMA 4 will not be acceptable.

2. Outlet boxes in unplastered brick or block walls shall be provided with deep square-cut device covers. They shall be set so that the brick or block can be cut and fitted closely to the cover opening and so that the standard wall plate will cover the joint between the brick or block and the box.

3. All outlet boxes used for supporting fixtures shall be furnished with malleable iron fixture studs of "no-bolt" type secured by locknut. Provide support for boxes occurring in suspended ceilings. Outlets in ceilings directly on bottom of joists shall be supported independent of ceiling construction. Outlets in suspended

ceilings shall not be supported from ceiling construction.

4. All boxes, whether outlet, junction, pull, or equipment, shall be furnished with appropriate covers.

5. No sectionalized boxes shall be used.

6. Back-to-back outlet boxes are not permitted. Separate boxes a minimum of 6" in standard walls and a minimum of 2 feet in acoustical walls.

7. Provide knockout closures for unused openings.

8. Provide blank coverplates on all unused boxes.

9. For multiple device installations, provide multi-gang boxes. Sectional boxes are not permitted. Provide barrier separation of different voltage conductors in the same box.

10. Thoroughly coordinate mounting heights of boxes with casework and backsplash heights.

11. Provide recessed outlet boxes in finished areas, supported from interior partition studs. Supports are to be stamped steel stud bridges for hollow stud walls and adjustable steel channel fasteners for flush ceiling outlet boxes.

12. Provide back supports for boxes in metal stud walls.

E. Junction and Pull Boxes:

1. Junction and pull boxes shall be furnished and installed as shown or where required to facilitate pulling of wires or cables. Such boxes shall be installed in accessible locations. All boxes for concealed work shall be constructed of 12 gauge USS galvanized sheet steel minimum, unless otherwise specified or indicated and provided with mounting brackets and flat screw covers secured in position by round head brass or stainless steel 300 grade machine screws. Boxes for exterior work shall be cast aluminum or galvanized cast iron type with threaded hubs unless otherwise directed. Gasketed cover plates shall be furnished for outdoor installation. Provide barrier (separators) where different system voltages share the same box.

2. Wherever possible, locate pull and junction boxes above accessible ceilings in finished areas.

3. Pull or junction boxes shall be supported independently of conduit.

4. In flush grade outdoor applications, unit shall be adequately supported against settling or tipping. Where heavy traffic or poor soil compaction exists, cast box in a concrete base which provides 6" of cover around and under the box.

3.3 INSTALLATION

A. Install raceways. Boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.

B. Furnish and install a separate and independent raceway system as shown on the Drawings for each of the various wiring systems including, but not limited to, the following:

Communications System
Control Wiring
Fire Alarm System
Incoming Telephone Service
Incoming Electric Service
Incoming CATV System
Lighting
Power 120/208 volt
Power 277/480 volt
Security System
Telephone Wiring

1. All raceway systems shall be completely wired as specified herein, shown on drawings and/or required for satisfactory operation of the various systems.

2. Raceways, generally, shall be concealed conduit as specified herein. Where wiring troughs are required or used to facilitate the wiring installation, they shall be equal to Square D Company's Square-Duct and fittings, with hinged cover arranged for total removal, all finished in baked enamel and all components U/L listed. The gutters shall be of ample size to accommodate conductors therein and as required by the NEC.

3. Underground conduits for services outside of building and entrance into building shall be as specified herein.

4. Support all conduit not embedded in concrete or masonry such that strain is not transmitted to outlet boxes and pull/junction boxes, etc. Supports to be sufficiently rigid to prevent distortion of conduits during wire pulling.

C. Minimum Raceway Size: 3/4-inch trade size (DN21).

D. Conceal conduit and EMT, unless otherwise indicated, within finished walls, ceilings, and floors.

E. Electrical Metallic Tubing (EMT) shall be used for the following unless otherwise indicated:

1. Branch circuits for lighting, receptacles, and power concealed in:

a. Dry wall construction.

b. Suspended ceilings.

c. Masonry walls.

2. Exposed in equipment room areas above 7'-0" above finished floors and as needed to serve fixed equipment.

3. Circuits for communication and signaling concealed in:

a. Dry wall construction.

b. Suspended ceilings.

F. Electric Non-metallic Tubing (ENT) may be used for circuits for communication and fire alarm in dry wall construction.

G. Security wiring shall be installed completely in raceway.

H**.** Telephone, data, public address**,** ATC (Automatic Temperature Control) fire alarm wiring shall be installed in raceway in partitions, terminated 8" above ceiling. Wiring above ceiling shall be plenum rated cable, where required by Code.

I. Rigid Galvanized Steel Conduit (RGS) shall be used for the following, unless otherwise indicated:

1. Branch circuits and feeders for lighting, receptacle and power, installed exposed up to 7'-0" above finished floor in areas subject to physical damage.

2. Circuits for communication and signaling exposed up to 7'-0" above finished floor in areas subject to physical damage.

J. Conduit shall be run concealed wherever possible, within walls, ceilings, or floors, unless otherwise indicated or specified. Where exposed conduits runs are shown or required, they shall be run parallel to building construction and shall be suitably supported at required intervals.

K. Conduit may be run exposed in Mechanical Equipment rooms, Electrical rooms, and where necessary in Storage rooms and unfinished areas. Where conduit is run exposed, it shall be run as close as possible to walls and ceilings and shall not interfere with equipment, ductwork and piping.

L. Keep raceways at least 12 inches (300 mm) away from parallel runs of flues, steam or hot-water pipes and other hot surfaces above 77 degrees F. Install horizontal raceway runs above water and steam piping.

M. Install raceways level and square and at proper elevations. Provide adequate headroom.

N. Complete raceway installation before starting conductor installation.

0. Support raceways as specified in Division 26 Section, *Hangers and Supports.* Arrange supports to prevent misalignment during wiring installation.

P. Use capped bushings or "push-penny" plugs to prevent foreign matter from entering the conduit system during construction. Clean and plug or cap all conduits left empty for future use.

Q. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab. Conduit stub-ups and stub-downs shall be arranged in a neat and orderly manner and shall emerge at right angles to floors or ceilings.

R. Make bends and offsets so the inside diameter is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.

S. Use raceway fittings compatible with raceways and suitable for use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings, unless otherwise indicated.

T. Run concealed raceways, with a minimum of bends, in the shortest practical distance considering the type of building construction and obstructions, unless otherwise indicated.

U. Conduits shall not be installed in elevated concrete floor slabs so that composite action between the slab and beams is not affected. Conduits may be installed in grade level concrete floor slabs with the following limitations:

1. Maximum size - 1-1/4".

2. Minimum concrete cover — 1.0", above and below.

3. Minimum spacing between conduits - 6" on center.

4. Conduit outside diameter - 1 /3 of slab thickness.

5. Installed between bottom and top reinforcing, and centerline of conduit at the mid-depth of the slab.

6. Secured to prevent possible change in position, sagging, or shifting as concrete is poured.

7. Water or damp-proofing integrity of slab is not disturbed.

V. Conduits larger than 1-1/4" may be installed in concrete floor slabs only with the specific permission of the Engineer, or as specifically indicated on the drawings, all in accordance with the above limitation.

W. Conduits in close proximity to each other at panelboards, etc., shall be located and wrapped with wire mesh to prevent cracking of slab.

X. Transition non-metallic tubing to rigid steel conduit before rising above the floor.

Y. Space raceways laterally to prevent voids in the concrete.

Z. Run conduit parallel to or at right angles to main reinforcement. When at right angles to reinforcement, place conduit close to slab support.

AA. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.

BB. Run parallel or banked raceways together, on common supports where practical.

CC. Make bends in parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

DD. Join raceways with fittings designed and approved for the purpose and make joints tight.

1. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
2. Use insulating bushings to protect conductors.

EE. Tighten set screws of threadless fittings with suitable tools.

FF. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of the pull wire.

GG. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches (150 mm) above the floor. Install screwdriver-operated, threaded flush plugs flush with floor for future equipment connections.

HH. Install nonferrous conduit or tubing for circuits operating above 60 Hz.

II. Lubricants for pulling wires shall be approved for use with the types of wire and conduit installed.

JJ. PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.

KK. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

LL. Use conduit hubs or sealing lock nuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.

MM. Install no more than equivalent of three 90° bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use factory elbows for bends in metal conduit larger than 2 inches (50 mm) in size.

NN. Avoid moisture traps; provide junction box with drain fittings at low points in conduit system.

00. Die-cast fittings of pot metal will not be accepted.

PP. Do not install aluminum conduit embedded in or in contact with concrete.

QQ. Surface Metal Raceway: Install a separate green ground conductor in raceway from the junction box supplying the raceway to receptacle or fixture ground terminals.

1. Select each surface metal raceway outlet box to which a lighting fixture is attached to be of sufficient diameter to provide a seat for the fixture canopy.

2. Where a surface metal raceway is used to supply a fluorescent lighting fixture having central stem suspension with a backplate and a canopy (with or without extension ring), the backplate and canopy will serve as the outlet box and no separate outlet box need be provided.

3. Provide surface metal raceway outlet box, in addition to the back plate and canopy, at the feed-in location of each fluorescent lighting fixture having end stem suspension.

4. Where a surface metal raceway extension is made from an existing outlet box on which a lighting fixture is installed (provide a backplate slightly smaller than the fixture canopy), no additional surface-mounted outlet box need be installed.

RR. Conduits shall be free of any burrs, foreign objects, and water prior to conduit installation.

SS. Conduit placed against concrete or masonry above ground shall be fastened to the concrete or masonry with pipe straps or one screw clamp attached to the concrete by means of expansion screw anchors and screws. "Caddy Clip" type hangers or straps will be permitted only in non-exposed areas and restricted to $^{1}/2$ " to 3/4" conduit.

TT. Where conduits turn up out of concrete slabs and are not concealed by wall construction, bends shall be carefully made so that no portion of the radius is above the floor.

UU. Rigid conduit or electrical metallic tubing shall not be strapped or fastened to equipment subject to vibration or mounted on shock-absorbing bases.

VV. Conduit shall be installed in such manner as to insure against the collection of trapped condensation, and runs of conduit shall be without traps wherever possible. Drill 1/8" diameter weep hole where necessary.

WW. Conduits run to and from cabinets shall be run neatly, in accurate manner and shall emerge from the floors and ceilings at right angles thereto.

XX. Provide wall flanges and gasketing on conduits entering fan housings to minimize air leakage at points of penetration of housing.

YY. Conduit risers shall be rigidly supported on the building structure, using appropriate supports only.

ZZ. In equipment spaces, such as fan rooms, plenums, etc., conduits and outlets may be exposed, but shall avoid interference with ventilating ducts, piping, etc.

AAA. Exposed conduit installed adjacent to ventilating ducts shall be installed after the ducts are in place, and shall be run from ceiling or wall junction boxes in such manner as to retain accessibility to junction box covers and to permit future removal or replacement of ducts.

BBB. Conduits and other electrical items shall not be fastened to or supported from ventilating ducts but shall be separately supported. The method of supporting and details of the supporting members shall be reviewed by the Owner's Representative. In no case shall screws penetrate the sheet metal of the ducts.

CCC. Exposed conduit run on surface shall be supported according to Code and within three feet of each outlet, junction box, or cabinet, by galvanized malleable conduit clamps and clamp backs. Suspended conduits shall be supported every five feet by conduit hangers and round rods, or where two or more conduits are run parallel, by trapeze hangers suitably braced to prevent swaying.

DDD. Screws for all exposed work shall be stainless steel, unless otherwise noted.

EEE. Cadmium-plated steel screws may be used for interior dry locations only.

FFF. No running threads shall be cut or used.

GGG. Conduits which are installed at this time and left empty for future use and which are five feet or more in length, including all telephone and communication conduits shall have a non-ferrous, 600 lb. tensile strength drag line left in place for future use. All empty conduits including conduit stubs shall be tagged at all exposed ends with tags identifying the location of the end of the conduit.

HHH. In all instances where flush-mounted type panelboards are installed, provide spare (empty) conduits in accordance with schedule in Division 26 Section "Panelboards", Paragraph "Provision for Future Circuits at Flush-Mounted Panelboards". These conduits shall extend between the panelboard cabinet and a junction box located above accessible ceiling construction.

3.4 FLEXIBLE CONNECTIONS

A. Use maximum of six (6) feet (1830 mm) of UL Listed Flexible Metal Conduit (FMC) for recessed and semi-recessed lighting fluorescent fixtures; for equipment subject to vibration, noise transmission, or movement; for all motors. Use Liquidtight Flexible Metal Conduit (LFMC) in wet or damp locations, as defined per NEC. Flexible conduits shall not be used for indoor HID lighting fixture connections.

B. Grounding conductors with green colored insulation shall be extended through all flexible connections including fixture "whips", and fastened to terminals within the first junction boxes on either side of the flexible length.

C. Flexible connections shall be sized per the Contract Drawings, or as required in

accordance with Code; the more stringent requirement shall apply.

3.5 INSTALLATION OF TERMINATIONS

A. Where raceways are terminated with lock nuts and bushings, align the raceway to enter squarely, and install the lock nuts with dished part against the box. Where terminations cannot be made, secure with one lock nut, use two lock nuts, one inside and one outside of the box.

B. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.

C. Open ends shall be capped with approved manufactured conduit seals as soon as installed and kept capped until ready to pull in conductors.

D. Where conductors No. 10 or larger enter a raceway, cabinet, pull box, and junction box, the conductors shall be protected by an insulated bushing providing a smoothly rounded surface.

E. Double lock nuts shall be used at termination of rigid conduit in knock-out openings.

F. Ends of conduits shall be equipped with insulating bushings for 1" and smaller, and insulated metallic bushings for 1-1/4" and larger. Ends of conduit shall be temporarily capped prior to installation and during construction to exclude foreign material.

3.6 INSTALLATION OF BOXES

A. Provide grounding connections for raceway, boxes, and components as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors.

B. Set floor boxes level and adjust to finished floor surface.

C. Provide junction boxes, pull boxes, cable support boxes, and wireways as required for proper installation of the electrical work. Covers shall be accessible. Small junction boxes shall be similar to outlet boxes. Provide barriers (separators) where different system voltage wires share the same box.

D. Pull boxes, cable support boxes, and large junction boxes for indoor use shall be made of code gauge steel or no less than 12 gauge. Covers shall be held in place with stainless steel screws. Paint interior and exterior surfaces with rust-inhibitive paint. (Pull boxes and covers shall be hot-dipped galvanized.)

E. Boxes located outdoors and in damp or wet locations shall be cast metal or alloy, fitted with screw-fastened covers and gaskets, and with threaded conduit connections. Fasteners shall be stainless steel or brass.

F. Pull boxes shall be installed at all necessary points to prevent injury to the insulation or other damage that might result from pulling resistance or for other reasons necessary for proper installation. Pull box locations shall be approved by the Owner's representative prior to installation.

G. Where boxes are used in connection with exposed conduit, plain covers attached to the box with a suitable number of countersunk flat head machine screws shall be used.

H. Pull boxes with barriers shall have a single cover plate and the barriers shall be of the same gauge as the pull box.

I. Exposed pull boxes will not be permitted in finished spaces.

J. Location of pull boxes shall be coordinated with piping, ductwork, and other equipment so as to permit sufficient clearance for maintenance and access.

K. Pull boxes recessed in walls or partitions shall be provided with flanged type covers.

L. Outlet boxes and covers shall be sheet steel knockout type, zinc-coated, or cadmium-plated and shall be of proper Code size for the number of wires or conduits passing through or terminating therein, but in no case shall any box be less than 4" square. Covers for flush outlets shall finish flush with plaster or other finished surface. Approved factory-made knockout seals shall be used in all boxes where knockouts are not intact. Boxes in concrete shall be a type which will allow the placing of conduit without displacing the reinforcing bars. Additional pull boxes shall be installed as required to facilitate pulling of wires.

M. Outlet boxes for lighting fixtures shall be equipped with fixture supporting devices.

N. Outlet boxes for switches shall be of the gang type.

0. Outlet boxes for exterior use shall be of the weatherproof cast metal type, with threaded hubs.

P. [Floor boxes shall be pressed steel boxes with brass flange and covers. Floor boxes shall be concrete tight and adjustable and shall be equipped with appropriate fittings.]

Q. Each circuit in each pull box shall be marked with a tag guide denoting panelboard to which they connect.

R. Boxes shall be separated to prevent sound transmission. Back-to-back boxes shall not be used.

S. Outlet boxes shall include suitable plaster rings and covers or plates.

T. Unused knockout holes shall remain closed and those opened by error shall be closed with snap-in blanks.

U. Outlet boxes shall not be smaller than required by Code for the number and size of wires to be installed.

V. Outlet boxes installed in plenum ceilings shall be in accordance with applicable Codes.

W. Outlet boxes for exposed interior work and all exterior work shall be cast metal or alloy with screw-fastened covers and gaskets, and with threaded conduit connections. Fasteners shall be stainless steel or brass.

Y. Outlet boxes shall be installed true and plumb so that the covers or plates will be level and at uniform elevations for the types of outlets contained.

Z. Outlet boxes for toggle switches and pilot lights at doorways shall be located at the strike side of the door as finally hung.

AA. Outlet box locations as indicated shall be considered to be approximate only. Determine exact locations from architectural details or from field instructions and coordinate outlet box locations with the work of other trades.

BB. Install junction and pullboxes to be accessible. Boxes in plenum ceilings shall comply with Code requirements.

CC. Locations of junction and pullboxes requiring access panels shall be reviewed by the Owner's Representative.

3.7 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to Manufacturer and Installer that ensure coatings, finishes, and cabinets are without damage or deterioration at the time of Substantial Completion.

B. Repair damage to galvanized finishes with zinc-rich paint recommended by Manufacturer.

C. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

D. Steel conduit: Conduit that shows corrosion within the guarantee period shall be replaced.

3.8 CLEANING

A. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

B. After conduits (ducts) and accessories have been installed, and concreting operations completed, conduit runs shall be satisfactorily cleared of obstructions and foreign matter. Defects which might damage cable upon installation shall be corrected and the entire run to the nearest box or other termination point shall be cleaned.

END OF SECTION 260533

SECTION 260534 - CONDUIT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. This Section specifies the requirements for raceways, conduits and boxes.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. ANSI C80.1 - Rigid Steel Conduit, Zinc-Coated.
2. ANSI C80.3 - Electrical Metallic Tubing, Zinc Coated.
3. ANSI/NEMA FB 1 - Fittings and Supports for Conduit and Cable Assemblies.
4. ANSI/NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports.
5. ANSI/UL 1 - Flexible Metal Conduit.
6. ANSI/UL 5 - Surface Metal Raceways and Fittings.
7. ANSI/UL 360 - Liquid-tight Flexible Steel Conduit.
8. ANSI/UL 467 - Electrical Grounding and Bonding Equipment.
9. ANSI/UL 797 - Electrical Metallic Tubing.
10. ANSI/UL 870 - Wireways, Auxiliary Gutters and Associated Fittings.
11. ANSI/UL 884 - Underfloor Raceways and Fittings.
12. NEMA VE I - Metallic Cable Tray Systems.
13. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
14. UL6 - Standard for Safety, Rigid Metal Conduit.

15. UL514B - Standard for Safety, Fittings for Conduit and Outlet Boxes

16. ANSI/UL 651 - Schedule 40 and 80 Rigid PVC Conduit.

1.04 QUALITY ASSURANCE

A. 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.

B. Comply with NFPA 70.

1.05 SUBMITTALS

A. Product Data:

1. Submit manufacturer's product data for raceways, conduits, outlet boxes, and wireways.

B. Shop Drawings:

1. Submit Shop Drawings of the complete metal surface raceway system.

2. Shop Drawings shall include sizes and lengths of raceways as verified with laboratory furniture Shop Drawings, inside corners, outside corners, end caps, raceway cover spacing, grounding, branch circuiting and wiring including locations of service entrances, receptacle types and manufacturers, receptacle spacing, and receptacle labeling with proper voltage, phase, circuit and panelboard designations as indicated on the Drawings.

3. Submit firestopping installation Shop Drawings to cover the following scope, but not limited to. The Contractor shall obtain Owner’s approval prior to installation.

a. Product data sheet from a manufacturer that is specified by Section 07 84 13 Penetration Firestopping.

b. Dimensioned installation Shop Drawing detail(s) with UL listed firestopping assembly number that is associated to the same material manufacturer.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 WIREWAYS AND TERMINAL BOXES

A. Wireways and terminal boxes shall be of steel construction, oil-tight with knockouts.

B. Size shall be minimum 4 x 4 inches or as indicated on the Drawings.

C. Cover shall be hinged.

D. Fittings shall be so constructed to continue the “lay in" feature throughout the entire installation.

E. Provide all sheet metal parts with a rust-inhibiting phosphatizing primer coating and finished in gray enamel. All hardware shall be cadmium plated to prevent corrosion.

F. Inside Terminal Boxes: Provide 25-ampere, 300-volt industrial rated terminal blocks with marking strip. Mark strip with black ink identifying circuit connection. Provide nameplate on exterior of each terminal box indicating panelboard served.

2.03 CONDUIT AND FITTINGS

A. Manufacturers:

1. Conduit and Electrical Metallic Tubing: Allied Tube & Conduit or equal.

2. Fittings: Appleton Electric, Midwest Electric Products or O-Z/Gedney.

3. Expansion Fittings: O-Z/Gedney Type DX, Crouse-Hinds Type XC, or equal by Midwest Electric Products or Appleton Electric.

4. Flexible Metal Conduit and Fittings: Anaconda Sealtite, Type UA.

B. Application:

1. Conduit and fittings for all electrical systems on this Project shall include the following:

a. Service entrance.

b. Electrical power and lighting feeders.

c. Electrical power and lighting circuits.

d. Building automation systems (BAS).

e. Fire alarm and signaling systems.

f. CCTV rough-in system.

g. Telecommunications rough-in system (minimum 6-inch bending radius for telecommunications conduits).

h. Nurse call system.

i. Security systems.

j. Other electrical systems, as identified on the Drawings.

C. For each electrical wireway system indicated, provide a complete assembly of conduit, tubing or duct with fittings including, but not necessarily limited to, connectors, nipples, couplings, locknuts, bushings, expansion fittings, and other components and accessories as needed to form a complete system of the type indicated.

D. Conduit fittings shall be designed and approved for the specific use intended. Conduit fittings, including flexible, shall have insulated throats or bushings. Rigid conduits shall have insulated bushings, unless grounding bushings are required by NEC Article 250-28. Grounding bushings shall have insulated throats.

E. Rigid metal conduit shall be hot-dipped galvanized. Fittings shall be threaded type.

F. Electrical metallic tubing shall be galvanized. Fittings shall be all steel set screw deep socket UL marked and approved for the application. Compression fittings uses shall be in, not limited to, wet damp and environmental areas type.

G. Flexible metal conduit and fittings shall be zinc-coated steel.

H. Liquid-tight flexible conduit and fittings shall consist of single strip, continuous, flexible interlocked, double-wrapped steel, galvanized inside and outside, forming smooth internal wiring channel with liquid-tight covering of flexible polyvinyl chloride (PVC).

I. Crimp type fittings are not acceptable.

J. Raceways such as electrical nonmetallic tubing (ENT) and liquid-tight flexible nonmetallic conduit (LFNC) are not acceptable for use on any Project.

2.04 WALL AND CEILING OUTLET BOXES

A. Manufacturers: Appleton Electric, RACO-Hubbell, Thomas & Betts - Steel City, Cooper Crouse-Hinds.

B. Galvanized steel interior outlet wiring boxes of the type, shape and size, including depth of box, to suit each respective location and installation; constructed with stamped knockouts in back and sides, and with threaded holes with screws for securing box covers or wiring devices. Minimum switchbox depth shall be 2 inches. Outlet boxes for electrical power shall be 2-1/8 inches deep. Outlet boxes for communication (voice and data) shall be minimum 3-1/2 inches deep.

1. Provide outlet box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes.

2. Accessories shall be compatible with outlet boxes being used and shall meet requirements of individual situations.

C. Corrosion-resistant cast-metal weatherproof exterior outlet wiring boxes of the type, shape and size, including depth of box, with threaded conduit ends, cast metal faceplate with spring-hinged waterproof cap and corrosion-proof fasteners.

D. Outlet boxes in poured concrete shall be plenum type without holes and with reset knockouts. Where extension rings are used to offset conduit between wall reinforcing steel, joint between extension ring and box shall be sealed to prevent concrete from entering box during pour.

2.05 FLOOR BOXES

A. Manufacturers: RACO-Hubbell, Wiremold, FSR.

B. Boxes shall be NEMA OS 1, fully adjustable, minimum 1-1/2 inch depth for electrical power only; 4-1/2 inch minimum depth for communication.

C. Boxes shall conform to regulatory requirements for concrete-tight floor boxes.

D. Service fittings shall be as specified on Drawings.

E. Poke-thru box fittings shall maintain a minimum two-hour fire rating.

2.06 PULL AND JUNCTION BOXES

A. Boxes shall be galvanized sheet metal with screw-on cover and welded seams, stainless steel nuts, bolts, screws and washers.

B. Boxes larger than 12 inches in any dimension shall be panelboard code gauge galvanized steel with hinged cover.

C. Boxes shall be sized In accordance with NEC.

2.07 CABLE TRAY AND FITTINGS

A. Manufacturers: Square D, B-Line, Chalfont.

B. Material: Hot rolled, carbon steel strip, hot-dipped galvanized after fabrication with either hot-dipped galvanized or cadmium-plated fasteners.

C. Dimensions: (exceptions as noted on Drawings):

1. Depth: 6 inches or as indicated otherwise.

2. Width: 24 inches or as indicated otherwise.

3. Radius: 36 inches or as indicated otherwise.

D. Type: Ladder.

E. Covers: Where indicated on the Drawings, provide trough-type cable tray with galvanized bolt-on covers.

2.08 SURFACE METAL RACEWAYS

A. Manufacturers: The Wiremold Company 3000 or 4000 Single-Channel System. Systems of other manufacturers may be considered equal if they meet all performance standards as specified herein. Wiremold 4000 shall be used for communication applications.

B. Raceway base and cover sections shall be UL Listed, manufactured of cold rolled steel, and finished in gray enamel.

1. Raceway shall be a two-piece design with a metal base and a snap-on metal cover.

2. Surface metal raceways installed in controlled environmental and cold rooms. Install gasket flip type weather resistant cover plates in lieu of stainless cover plates for receptacles.

C. Furnish with all entrance fittings, elbows, end caps, covers, and device brackets and plates as indicated on the Drawings for a complete system.

1. Fittings shall be finished in enamel to match the raceway.

2. Fittings shall be supplied with a base where applicable to eliminate mitering.

D. Provide couplings, elbows, connectors, boxes, extension rings and outlet covers specifically designed for use with surface raceway system.

E. Provide factory fittings for vertical raceway riser connection to horizontal raceway runs. Such directional change fittings must accommodate required radius flex for Category 6a communication cable under both load and no load conditions.

F. All internal exposed surfaces within the raceway, including joints and covers shall be free of nicks, cuts, sharp edges, and other imperfections.

G. Grommets shall be used to accommodate building automation system cabling to critical equipment or as noted on Drawings.

H. Multiple raceways shall be provided for normal power, emergency power, and communication / critical alarm as noted on the Drawings.

1. Raceway lengths shall be as shown on the Drawings.

I. Multi-Outlet Assembly Devices:

1. Provide hospital grade, duplex receptacles mounted 12 inches on center unless noted otherwise. Unless otherwise noted, alternate circuits between receptacles.

2. In laboratory applications, normal hospital grade power receptacles shall have alternating colors for different circuits:

a. Phase A = gray

b. Phase B = brown

c. Phase C = white

3. Exceptions to the color would be single circuit raceway, which shall be white.

4. Receptacles serving emergency circuits shall be red in color.

5. Isolated ground receptacles shall be orange in color.

PART 3 - EXECUTION

3.01 INSTALLATION - GENERAL

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Concrete metal hit anchor and fastener is an unacceptable fastening system for concrete, brick and block.

D. Where raceways or cable trays penetrate fire-rated floors or roofs, sleeve and seal opening around raceways and cable trays with UL listed firestop assemblies equal to fire rating of floors or roofs. Seal penetrations through all floors or roofs to provide and maintain a watertight installation. Conduit sleeves, where required, shall be two (2) trade sizes larger for proper sealing and extend 2 inches above the surface. Refer to Section 07 84 13 Penetration Firestopping and Section 09 29 00 Gypsum Drywall for sealing and firestopping requirements where raceways penetrate smoke, fire, and sound rated walls. The installation shall be in compliance with UL listed firestopping assembly.

E. Support all conduits and J-boxes above ceilings from the building structure. All J-boxes being installed above suspended ceilings must have a minimum of 12-inch clearance from the top of the ceiling grid except where approved by the Owner in writing prior to installation.

F. No raceways, metallic or non-metallic, flexible or rigid, shall be installed in any floor slab elevated above slab on grade. The only exception may be for the lighting grid in the parking deck areas of a parking garage.

G. Bushings and throats shall be installed for fittings, raceways, boxes or other enclosures prior to installing cables and wiring systems.

H. Provide raceway support in intervals not exceeding the maximum spacing per NEC.

3.02 INSTALLATION - CONDUIT

A. Install raceway and conduit system from point of origin in outlets shown, complete with offsets, pull boxes, junction boxes and fittings.

B. Installation of all new conduits must be minimum 12 inches from ceiling grid except where approved by Owner.

C. No raceway shall be run horizontally inside of walls or partitions. Exceptions: building perimeter walls under windows, clerestory panel walls, and where structural conditions do not allow vertical access to tops of walls. The contractor shall obtain written approval from the Owner for exceptions prior to installation.

D. Install rigid wall hot-dipped galvanized steel conduit. Minimum size shall be ½-inch unless noted otherwise on the Drawings. Minimum size for communication shall be 1-inch. The following exceptions are permitted:

1. Electrical Metallic Tubing (EMT): In sizes ½-inch up to and including 4 inches, may be used inside dry locations where not subject to mechanical damage. ½-inch EMT may only be used for connections between distribution J-boxes in the ceiling and J-boxes in the walls within the same room, serving 15-20 Amp single phase receptacles, lighting occupancy sensors, switches, dimmers, and fire alarm respectively. In such application the length of ½-inch EMT shall not exceed 25 feet. EMT shall be used in air-conditioned spaces, such as accessible ceilings, and dry wall partitions. EMT shall not be used outside, in concrete, underground, in underfloor spaces, in masonry walls and in locations likely to be damp. EMT shall not be used for circuits with system voltage over 480 volts.

2. Liquid-tight Flexible Metal Conduit:

a. Install liquid-tight flexible metal conduit for connections to rotating, vibrating, moving or movable equipment, including dry-type transformers. Install internal ground wire on flexible conduit with grounding bushings.

b. Maximum length shall be four (4) feet, minimum two (2) feet; minimum size shall be ½-inch.

3. Flexible Metal Conduit:

a. Where required, install standard flexible steel metal conduit (not liquid-tight) with internal ground wire, in spaces above ceilings.

b. Install flexible conduit connection such that vibrations are not transmitted to adjoining conduit or building structure. Maximum length shall be four (4) feet, minimum two (2) feet; minimum size shall be ½-inch.

c. Communication flexible conduit size in walls shall be minimum 1-inch.

d. Flexible conduit for lay-in fixtures may be 3/8-inch factory whip assemblies (6 feet maximum).

e. Flexible conduit for receptacles in office applications can be used in the walls as long as the flexible conduit length does not exceed 12 feet and the flexible conduit run is not horizontal. Where fished in existing walls, the length shall not exceed 12 feet.

4. PVC Conduit:

a. Utilize PVC conduit for underground outdoor installations, minimum size 1-inch. All PVC conduit runs shall have PVC coated rigid steel stub outs from the ground, including the last 90 degree bend.

b. All underground PVC conduit shall be installed in concrete with 12-inch x 12-inch x 3-inch concrete markers at every 100 feet and at every turn in direction.

c. All underground conduits shall be encased in concrete and shall have their locations identified by a warning tape that is placed in the trench at least 12 inches above the underground installation. Provide trace wire for major underground feeders.

d. Warning tape. Underground cable and conduit detectable marking tape shall be 6 inches wide, red with black letters, imprinted with "CAUTION – BURIED ELECTRIC CABLE BELOW" or similar. Tape shall be installed a minimum of 12 inches above the underground installation, and not more than 12 inches below finished grade. Warning tape shall be visible at the point where the conduit emerges above ground at the service stubs. Where fiber optic cable is to be installed in the conduit, an underground cable marking tape with a metallic detection strip shall be imprinted with 'CAUTION – BURIED FIBER OPTIC CABLE BELOW' or similar. Splicing of the tape shall be accomplished with metal clips to maintain electrical continuity along the length of the tape. Splices shall be wrapped with a waterproof adhesive tape.

5. PVC Coated Rigid Steel Conduit:

a. PVC coated rigid steel conduit may be direct burial for underground installation when concrete encasement is not required.

b. The PVC coated conduit shall be hot dip galvanized inside and out. The PVC coated conduit factory-cut threads shall be protected with hot galvanized threads and a clear urethane coating. Thread protectors shall be used on the exposed threads of the PVC coated conduit. The PVC coating must have been investigated by UL as providing the primary corrosion protection for the rigid galvanized steel conduit. The PVC coated rigid galvanized steel conduit must be certified and authorized to wear the ETL Verification Mark.

c. Ferrous fittings for general service locations must be UL Listed with PVC as the primary corrosion protection.

d. A PVC sealing sleeve extending one pipe diameter or two inches, whichever is less, shall be formed at every female fitting opening, except unions. The inside sealing sleeve diameter shall be matched to the outside diameter of the conduit.

E. Multiple Conduit Installation:

1. Install all conduits parallel to or at 90 degrees to the structure. Multiple conduits shall not be installed using a single rod support. Multiple conduits running the same direction with spacing 48 inches apart or less shall be installed on the same trapeze. Conduits shall be installed on metal framing constructed trapeze hangers that have minimum 24-inch width. Trapeze hangers shall be supported on minimum 3/8-inch diameter all-thread rod attached to the structure with coupling nuts and expansion bolts or beam clamps. Conduit straps or other devices specifically designed for the purpose shall be used to secure conduits to the metal framing. Wire ties and hanger wires are not permitted. Conduits shall only be installed on the top surface of the metal framing, with multiple layered trapeze supports if required. Hanger rods shall not extend more than 1 inch past the lower trapeze metal framing. Use double nuts for all-thread rods.

2. Where parallel conduits are strapped, fastened or anchored, the devices used shall be of the same type and installed on the same plane whether vertical or horizontal.

3. Conduit hangers from drop rod (like Caddy B18 Series) are acceptable only upon prior written approval from the Owner.

F. Single Conduit Installation:

1. Install single conduits parallel to or at 90 degrees to the structure and suspended from the structure on all thread rods (1/4-inch minimum) or clamped and/or clipped to the structure with manufactured clamps/clips. When single conduits are suspended from all thread rods, conduit clamps with bolts and nuts shall be used. Through partition wall penetration shall not be construed as a means of conduit support. Wire ties and hanger wires are not permitted. No powder actuated, compressed air, propane or similar powered “shot” anchor systems shall be installed under any circumstance. Wire ties and hanger wires are not permitted. Single conduits may be secured as follows:

a. Wood screws on wood.

b. Toggle bolts on hollow masonry.

c. Bolts and expansion anchors in concrete or brick.

d. Machine screws, threaded rods and clamps on steel.

e. Conduit clips on steel joists.

f. Plastic anchors are not allowed.

g. Conduit hangers from drop rod (like Caddy B18 Series) are acceptable only upon prior written approval from the Owner.

G. Fittings shall be approved for grounding purposes or shall be jumpered with a copper grounding conductor of appropriate ampacity. Leave termination of such jumpers exposed. Conduit and wireway systems shall not serve as branch circuit grounding conductors.

H. Install expansion fittings in metal conduit as follows:

1. Conduit Crossing Building Expansion Joints:

a. EMT all sizes.

b. Rigid Galvanized Steel (RGS) all sizes.

2. Conduits entering environmental rooms and other locations subject to thermal expansion and as required by NEC.

3. Provide conduit expansion fitting with an integral bonding braid, as in Crouse-Hinds Type XC.

4. Expansion fittings are not required where offsets, expansion loops, or flexible conduit are placed in conduit runs.

I. Install conduit concealed in walls, partitions and above ceilings. Install exposed in overhead conduit (at structure) of mechanical rooms and in other similar rooms where ceilings are not provided.

J. Avoid moisture traps where possible; where unavoidable, provide junction box with drain fitting at conduit low point.

K. Use suitable conduit caps to protect installed conduit against entrance of dirt and moisture.

L. Install pull wires in empty conduits. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Jetline 232 or equal by Greenlee. Leave at least 12 inches of slack at each end of pull wire.

M. Cap ends of spare conduits and extend into space above accessible ceiling a minimum of 18 inches. Label conduit as spare.

N. Do not daisy chain conduit installations in or on walls, provide a single conduit wall drop per device.

O. The support means for conduit installation, whether threaded rods, trapeze or other system, shall not be shared with non-electrical system. Any deviation from this standard due to space constrain shall be submitted to the Owner. Owner's review does not necessarily guarantee an approval; therefore the Contractor is advised not to start installation prior to final approval.

3.03 INSTALLATION - WIREWAYS AND TERMINAL BOXES

A. Bolt wireways and terminal boxes to steel channels fastened to the wall or in self-supporting structure. Install level.

B. Gasket each joint in oil-tight wireway.

C. Mount rain-tight wireway in horizontal position only.

3.04 INSTALLATION - BOXES

A. Provide electrical boxes as shown on Drawings, and as required for wire pulling, equipment connection, and code compliance. Electrical box locations shown on Drawings are approximate unless dimensioned. Verify location of outlets prior to rough in. Locate and install boxes to allow access and clearances per NEC.

B. J-boxes shall be provided for branch circuits in excess of 100 feet.

C. Provide outlet box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps, and metal strap for supporting outlet boxes. Accessories shall be compatible with outlet boxes being used and shall meet requirements of individual situations.

D. Do not install boxes back-to-back in walls. Provide minimum 6-inch separation in non-fire-rated walls. Provide minimum 24-inch horizontal separation in acoustic-rated walls.

E. Membrane penetration of minimum 1-hour, up to maximum 2-hour fire rating walls and partitions by recessed steel electrical boxes that do not exceed 16 square inches in area are permitted, provided the aggregate area of the openings does not exceed 100 square inches in any 100 square feet of wall area. The annular space between the wall membrane and the box shall not exceed 1/8 inch. Such boxes on opposite sides of the wall or partition shall be either separated by a horizontal distance of not less than 24 inches or separated by protecting both boxes by listed putty pads or other listed materials and methods.

F. Secure boxes rigidly to the substrate upon which they are being mounted, or solidly imbed boxes in concrete or masonry. Boxes shall not be permitted to move laterally. Boxes shall be secured between two studs. Boxes connected to one stud are not permitted.

G. Provide knockout plugs for unused openings.

H. Use multiple-gang boxes where more than one device is mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.

I. Install boxes in walls without damaging wall insulation.

J. Outlet boxes in plaster partitions shall be "shallow-type" set flush in wall so there is at least 5/8-inch plaster covering back of box.

K. Switch boxes shall not be used as junction boxes.

L. Typical outlet box centerline heights shall be as listed in the following table. Coordinate outlet heights with Architectural Drawings, millwork details, casework details and equipment installation. Where discrepancies occur, ask for an interpretation from the Architect/Engineer and Owner.

Function	Receptacles	Telecommunications
Offices	18-inches	18-inches
Corridors	18-inches	48-inches
Exam Rooms	48 or 18-inches	48 or 18-inches
Millwork	Coordinate with millwork	Coordinate with millwork
Casework	Coordinate with millwork	Coordinate with millwork
Headwalls	Refer to Architectural Drawings	Refer to Architectural Drawings
Mechanical/Electrical Equipment Rooms	48-inches	48-inches
Laboratories	Coordinate with casework	Coordinate with casework

M. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches of recessed luminaires, to be accessible through luminaire ceiling opening.

N. Outlet boxes supporting fixtures shall be securely anchored in place in an approved manner. Support outlet boxes and fixtures in acoustic ceiling areas from building structures with separate supports, not from acoustic ceiling or ceiling tile wire. Lighting fixture outlets shall be coordinated with mechanical and architectural equipment and elements to eliminate conflicts and to provide a workable neat installation.

O. Locate pull boxes and junction boxes above accessible ceilings or in unfinished areas.

P. Support pull and junction boxes independent of conduit. Combination box/conduit hangers from drop rod (like Caddy B18 Series) are acceptable only upon prior written approval from the Owner.

Q. Use cast floor boxes for installations in slab on grade; formed steel boxes are acceptable for other installations. Set floor boxes level, and adjust floor box flush with finish flooring material.

3.05 INSTALLATION - CABLE TRAY

A. Coordinate cable tray installation with piping ductwork and light fixture installation. Maintain clearance inside cable tray for installation of cables. Install according to manufacturer's instructions. Provide "Caution - Do Not Use As Walkway" signs suitably displayed as designated by the Owner.

B. Avoid proximity to light fixture ballast (minimum 12-inch clearance) since electronic fields can cause interference with some telecommunication signals.

3.06 INSTALLATION - SURFACE METAL RACEWAYS

A. All raceway systems shall be installed complete, including insulating bushings and inserts where required by manufacturer’s installation sheets. All unused raceway openings shall be closed.

B. Install raceways above ceilings, exposed, on walls and casework parallel to or at right angles to structure and casework. Securely support raceway at intervals not exceeding 10 feet or in accordance with manufacturer's recommendations.

C. The number of conductors installed in any raceway shall not be greater than the number for which the raceway is approved.

D. Maintain grounding continuity between raceway components to provide a continuous grounding path by means of separate insulated code-size grounding conductors.

   1. Each equipment grounding conductor in a conduit homerun entering the raceway shall be connected to the ground terminals of the receptacles.

END OF SECTION 260534

SECTION 260544 - UNDERGROUND DUCTBANKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections apply to this section.

1.2 SUMMARY

A. This Section includes complete concrete ductbank construction and direct burial materials and methods for outside power and communications systems transmission and distribution.

B. This section specifies underground duct placement, materials, and installation procedures.

1.3 CONTRACTOR RESPONSIBILITIES

A. All work described in this Section shall be performed and paid for under Division 26.

B. Existing Subsurface Utilities: Existing subsurface facilities are shown on the plans to help the Contractor avoid damage to essential utilities which must remain in service. Take reasonable steps to ascertain the exact location of all underground facilities prior to doing work that may damage such facilities. If the discovery of underground facilities not indicated on the plans or in a location different from what is indicated on the plans, protect such facilities, notify the Owner's representative immediately, and record actual conditions found onto the record drawings.

C. Construction Staking:

1. Provide the stakes and reference marks necessary for the construction of the improvements covered by this Contract.

2. Control stakes which constitute reference points for all Construction work shall be conspicuously marked with red flagging tape. Provide responsibility to inform employees and Subcontractors of the stakes' importance, and the necessity for their preservation. The cost of replacing such controls, should it become necessary for any reason whatsoever, shall be furnished at no additional cost to the Owner.

1.4 QUALITY ASSURANCE

A. Installer: Company specializing in cast-in-place concrete structures with a minimum of three years documented experience.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1, or an equivalent Certification program.

B. Materials: All materials shall be new and the best of their respective kinds, free from all defects and as specified on the plans and the specifications or as accepted by the Project Engineer. Furnish materials or manufactured articles or shall do work for which no detailed Specifications are set forth, the materials or manufactured articles shall be of the best grade in quality and workmanship obtainable on the market from firms of established good reputation, or if not ordinarily carried in stock, shall conform to the usual standards of first-class materials or articles of the kind required, with due consideration of the use to which they are to be put. In general, the work performed shall be in conformity and harmony with the intent to secure the best standard of Construction and equipment of the work as a whole or in part.

C Manufacturer's Recommendations: Whether specifically mentioned or not in these Specifications, all materials, equipment, devices, etc., shall be installed in a manner meeting the approval of the manufacturer of the particular item.

D. Codes and Standards: Provide underground ducts and manholes conforming to the following:

1. National Electrical Manufacturers Association (NEMA) - Conform to the manufacturing standards of the following:

   a. TC 2: Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).

   b. TC 3: PVC Fittings for Use with Rigid PVC Conduit and Tubing.

2. Underwriters Laboratories, Inc. (UL): Conform to the following:

   a. 651: Schedule 40 and 80 Rigid PVC Conduit.

3. American Concrete Institute (ACI):

   a. 318: Building Code Requirements for Reinforced Concrete.

4. American Society for Testing & Materials (ASTM)

   a. F512: Smooth-Wall PVC Conduit & Fittings for Underground Installation.

E. Certification: Manufacturer shall be a company specializing in ductbank structures with a minimum five years documented experience.

1.5 SUBMITTALS

A. Submit shop drawings and product data for all conduit, duct, ductbank materials, accessories, and miscellaneous components. Submit product data for each type of manufactured material and product indicated.

B. Indicate material specifications, dimensions, capacities, and reinforcing details. Submit concrete product data, concrete mix design, and certified mill test reports for steel bars.

C. Submit coordination shop drawings of ductbank and underground cable installations including profiles and elevations of all utility crossings. Proposed deviations from details

on the Drawings shall be clearly marked on all Submittals.

D. Record Documents: Show dimensional locations of underground ducts, and handholes.

1.6 SITE CONDITIONS

A. General: Clearing work shall not begin until temporary fences, barricades, warning signs and other pedestrian control devices are installed.

B. Traffic Access:

1. Conduct operations and schedule cleanup in a manner which causes the least possible obstruction and inconvenience to adjacent property owners, pedestrians and vehicular traffic. Furnish, erect, construct and maintain such temporary fences, barriers, lights, reflectors, cones, signs, ramps, etc., that may be necessary to adequately provide separation and warn the public of work in progress and of any existing dangerous conditions. This requirement shall apply continuously and shall not be limited to normal working hours.

2. Provide responsibility for coordinating and obtaining approvals of the location for temporary barricades and/or detours of traffic from the Police and Fire Departments.

3. If peripheral fencing is used it shall be provided with reflectors, flashers, signs, dangles, or barricades as the fence is being built.

4. Maintain continued access to parking areas, roads, abutting properties, and other facilities which the construction will cross.

5. If traffic is reduced to one way, provide a flag person. A minimum of one lane shall be maintained open to traffic at all times.

6. When entering or leaving road ways carrying public traffic, the equipment whether empty or loaded, shall in all cases yield to public traffic.

7. Supply and maintain cone placements at his sole additional expense.

8. All traffic signs which fall within the line of Construction or are obstructed by the equipment or operations shall be temporarily relocated to an unobstructed area. Temporarily relocated traffic signs shall be returned to their original location at the end of construction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering the specified products that may be incorporated in the work, include, but are not limited to, the following:

1. Conduit and Fittings:

a. Carlon Electrical Products.

b. George-Ingraham Corporation.

c. Condux International.

2. Ductbank Accessories:

a. Carlon.

b. Osbum Associates.

c. Underground Devices, Inc.

d. OZ/ Geurney

2.2 UNDERGROUND DUCTBANKS

A. General: Underground ductbanks to be arrangements of single bore, PVC plastic conduits, concrete encased. The number and size of conduits to be as indicated. Turn up connections through slabs or floors shall be rigid metal.

B. Material:

1. Conduit and Fittings:

a. Type II, heavy wall Schedule 40 PVC plastic, sunlight UV-resistant, in accordance with the requirements of NEMA publications TC-2 and TC-3 (fittings).

b. Rigid galvanized heavy wall steel conduit (UL 6) with threaded couplings.

c. Conduit and fittings shall have a temperature rating at least equal to the operating temperature of the cable which it contains, minimum 90 degrees C. Conduit and fittings shall be free from all substances that injuriously affect any wire or cable insulation.

d. The Manufacturer shall certify that the plastic is 100 percent virgin material and the finished product meets the specifications. All PVC conduit and fittings shall have solvent-weld connections and shall provide a water-tight joint.

2. Concrete: Comply with ACI 318 — 3.000 psi test in 28 days - See Division 033000, *Cast-in-Place Concrete.* As follows:

a. Cement: Portland Blast-Furnace Slag Cement, Type IS or equal meeting ASTM C593M Specifications and the requirements of ACI 318 and 301.

b. Fine Aggregate: Concrete sand meeting requirements of ASTM C33.

c. Course Aggregate: ASTM #57 crushed limestone, meeting requirements of ASTM C33.

d. Air Entraining Admix: Complies with ASTM C260 Standard Specifications

for Air Entraining Admixtures for Concrete.

e. Water: Complies with ASTM C94 Standard Specifications for Ready-mixed Concrete.

3. Use pea gravel aggregate for void-free duct penetration.

4. Reinforcing: Deformed conforming to ASTM A615 - Grade 40, minimum 3/4". Provide coated rebar where exposed to earth, such as on ductbank stubouts. Bars shall be free of loose scale, rust, or other coatings that will reduce bond.

5. Spacers: Manufactured precast plastic assembly, base spacer, top spacers and intermediate spacers, to maintain 3-inches between conduits and completely enclosed and locked conduit assembly. Set on masonry leveling blocks prior to pour.

6. Joint Sealant: Watertight as recommended by conduit manufacturer.

7. Cable Sealing Bushings: OZ type CSB, with PVC coated discs, or equal.

8. Thruwall and Floor Seals: OZ type *FSK* or *WSK*, or equal.

9. Expansion Joints: Expansion joints shall be *Dylite*, as manufactured by Copper. Scorogord, or Dow Chemical and shall conform to ASTM D-1752, Type

10. Construction Joints: Construction joints shall be formed using *Jahn* Screed joint materials as manufactured by Superior Concrete Accessories. Inc.

C. Conduit:

1. Size as indicated on the Drawings. If conduit sizes are not indicated on the Drawings, then the conduits shall be sized as follows:

a. Four inches nominal for 600 volts or lower and for Communication

b. Five inches nominal for voltages above 600 volts.

D. Elbows: rigid heavy wall galvanized steel with a minimum bend radius of 36 inches (915 mm).

E. Conduit Termination in Utility Holes and Buildings

1. Bushings: Pre-manufactured groundable steel bushings of appropriate sizes where bell ends are not used. Steel bushings shall be used on all metal conduit.

2. Seals: When entering, below grade, an existing building the concrete shall be core-drilled for the appropriate size conduit and seal. The seal shall be a mechanical interlocking assembly seal of modular synthetic rubber links properly sized to fit the pipe and tightened in place, in accordance with the manufacturer's instruction.

3. Fire Stopping/Sealant: All cable filled conduits shall be sealed with 3M Fire Barrier 2001 Silicone RTV Foam Conduit Sealant manufactured by 3M Fire

Protection Products, or approved equal.

F. Plugs: Closure plugs or caps of the same material as the conduit at the ends of the unused sections at manholes, and at building entrance openings.

G. Pull wire: Provide a polypropylene, twisted yellow, rot and mildew-resistant 3/8" minimum pull rope (2400 lbs. tensile strength) in each empty duct.

H. Grounding: Steel grounding bushings shall be grounded to the manhole or junction box ground. On steel conduit with end bells, provide an Appleton Catalog No. XJB Series or equal bonding fitting with bonding strap. Connect bonding strap to ground wire in manhole or junction box.

I. Drainage Assembly: All ducts shall drain to an open end - preferably to a handhole or away from the building.

2.3 ACCESSORIES

A. Duct Supports: Rigid PVC spacers selected to provide minimum duct spacings and concrete cover depths indicated, while supporting ducts during concreting. Spacers shall be interlocked horizontally only. Provide nylon tie-downs to hold ducts to spacers. Concrete blocks are prohibited for duct spacers.

B. End Bells: Flared, smooth-surfaced fittings of same material as conduit; if of different material, including adapter for connection to conduit.

C. Warning Tapes:

1. Non-biodegradable, polyethylene tape, 8 mil thick and a minimum of 6 inches wide with detectable metallic foil. Provide warning labels on 3 foot centers which shall be colored as follows:

a. For communication ducts: yellow tape with black printed labeling: *WARNING - COMMUNICATION DUCT*

b. For electrical ducts, piping or cable, red tape with black printed labeling: *WARNING - BURIED ELECTRICAL CABLE.*

2. Bury marker tape 12-inches below grade above every ductbank and buried conduit.

2.4 TEST PITS

A. Provide test pits to locate all utilities and structures. Provide test pits as necessary to determine actual locations and profiles of obstructions to proposed new work.

B. Verify existing utilities, locations, and inverts and points of connection.

PART 3 - EXECUTION

3.1 LOCATION AND LAYOUT

A. Indicated plans and profiles – approximate, based on field information and available as-built plans.

B. Actual locations and profiles - based on test pits to locate all shown utilities and structures. Test pits at beginning, center, end, and at all ductbank bends and utility crossings.

C Plan and profile adjustments - All provided at no additional cost to Owner, subject to approval.

D. Examine site to receive ducts and handholes for compliance with installation tolerances and other conditions affecting performance of the underground ducts and manholes. Do not proceed with installation until unsatisfactory conditions have been corrected.

E. Connection to existing duct banks - Contractor to verify location and inverts of existing duct banks, at points of connection.

3.2 INSTALLATION

A. In accordance with NEMA publication TC-2 and manufacturer's recommendations.

B. Top of envelope below grade - Minimum as indicated on the Drawings (600 volts and below).

C. Concrete envelope - 3 inches minimum beyond surface of any conduit, minimum 3 inches between conduits. Top of ductbank shall be crowned to prevent puddling of water.

D. Seal and Thru Wall Fittings - At entrances to buildings for watertight construction.

E. Sweeps and bends - Minimum 25 foot radius (except at conduit risers) unless otherwise approved to accomplish changes in direction of runs either horizontally or vertically. Double offsets: Minimum 100 foot radius. Sweep bends may be made up of one or more curved or straight sections or combinations thereof. Manufactured bends shall have a minimum radius of 36 inches.

F. Mandrel conduits - Mandrel 12 inch long, 1/4 inch less than conduit I.D. Draw a testing mandrel through each duct.

G. Clean conduits - After mandrel, with stiff brush, leave no particles or debris. Immediately install end plugs after cleaning.

H. Pull Line - Provide 100-pound-tested nylon pull line in all conduits, including spares. Provide 3 feet of slack at each end of conduit and tag.

I. Stagger vertical conduit joints - minimum 6 inches. All joints shall have couplings installed.

J. Reinforcing steel - Provide reinforcing steel the entire length of the duct system. Provide four #4 bars, one in each corner minimum overlap the joints 12-inches, and tie them into the respective utility, vaults, and buildings, etc. Rebar shall not be installed less than 2-inches from sides of any duct.

3.3 EXCAVATION, BACKFILLING, COMPACTING AND SITE PREPARATION:

A. Provide all excavating and backfilling and site preparation necessary to install underground ductbanks, cables. etc., included in this section of the work. Excavation and backfill shall be performed in accordance with the requirements of the *General Electrical Requirements* Section 260501.

B. Install forms on sides of the ductbank if the trench is not of the proper firmness to prevent cave-in. Provide all required excavating, shoring, sheeting, bracing, and backfilling.

C. The bottom of the trench shall be undisturbed earth. If the trench bottom is too low for proper grade, fill to the proper level with sand and mechanically compact it. Cut trenches neatly and uniformly.

D. Each excavated section from manhole to manhole and from manhole to building shall be completely excavated and graded before any duct is laid in that section.

E. Provide underground detectable warning tape 12-inches below finish grade over all ductbanks.

F. Excavation and Backfill: Conform to Division *Earthwork*, but do not use heavy-duty, hydraulic-operated compaction equipment.

G. After excavation of the trench, stakes shall be driven in the bottom of the trench at four-foot intervals to establish the grade and route of the duct bank.

H. Pitch the trenches uniformly towards manholes or both ways from high points between manholes for the required duct line drainage. Avoid pitching ducts towards buildings wherever possible.

I. The walls of the trench may be used to form the side walls of the duct bank provided that the soil is self-supporting and that concrete envelope can be poured without soil inclusions. Forms are required where the soil is not self-supporting.

J. After the concrete-encased duct has sufficiently cured, the trench shall be backfilled to grade with earth.

K. Restore surface features at areas disturbed by excavation, and reestablish original grades except as otherwise indicated. Replace removed sod as soon as possible after backfilling is completed. Restore all areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, or mulching. Perform according to Division 32, Section *Exterior Improvements.*

L. Restore disturbed paving. Refer to *Paving* in Division 32.

M. Remove pavements, sidewalks, curbs, and gutters where necessitated by construction of ducts.

N. Place temporary bituminous pavement in accordance with Section 321216 *Asphalt Paving*, when required by the sequence of operations.

0. On completion of distribution systems construction, replace pavements, sidewalks, curbs and gutters.

P. Surplus earth from the trenches, after compacting, shall be removed and disposed of.

3.4 CUTTING AND PATCHING

A. Existing Obstructions: Where drawings indicate that underground conduits are to cross under existing roadways, walks or other similar paved areas, steel conduits will be driven under such areas in lieu of installing the conduits in trenches as specified above. After installation of conduit by either method, all existing paved or grass areas which have been disturbed in any way shall be restored to their original conditions. Where drawings indicate spare conduits under existing roadways, walks, and other similar paved areas, all ends of conduits shall be capped five feet beyond the pavement and adequately protected from mechanical damage. The ends of these conduits shall be marked by the placement of concrete monuments. Minimum size shall be 6 inches in diameter by 18 inches long set flush in ground with "S/C indented in top to signify spare conduit.

B. Conduit Protection at Penetrations: Galvanized conduits which penetrate concrete shall be PVC-coated and shall extend at least 2 inches within the concrete to the first coupling or fitting outside the concrete.

C. Provide all cutting and patching necessary for the installation of the ductbank work. Any damage done to the work already in place by reason of this work shall be repaired at the Contractor's expense by a qualified mechanic experienced in such work. Patching shall be uniform in appearance and shall match with the surrounding surface.

D. Patching shall be done in accordance with the requirements of Division 32 for the appropriate disturbed surface materials.

E. Work with extreme care near existing ducts, conduits, cables, and other utilities to avoid damaging them.

3.5 PLACEMENT OF CONDUIT

A. Within five (5) feet of each existing building wall or utility hole penetration, install heavy wall galvanized steel conduit within the concrete envelope to provide protection against vertical shearing.

B. Core drill all existing walls, footings and utility holes, and waterproof per Division 26 using an assembly of rubber links of mechanical seal of the proper size for the pipe and tighten in place, in accordance with the manufacturer's instruction, after the new conduit is installed.

C. Install spacers as recommended by the conduit manufacturer and requirements stated above but not to exceed a maximum of four feet on center for PVC conduit and eight feet on center for steel conduit. Bottom spacers shall rest on 8-inch x 16-inch x 2-inch minimum concrete pads to prevent them from sinking into the ground and reducing the bottom concrete cover. Stagger conduit joints in concrete encasement 6 inches minimum horizontally.

1. Spacer assembly shall consist of base spacers, intermediate spacers, and top spacers to provide a completely enclosed and locked conduit assembly.
2. Before placing concrete, anchor duct bank assemblies to prevent the assemblies from floating during concrete placement. Anchoring shall be done by driving reinforcing rods adjacent to every other duct spacer assembly and attaching the rod to the spacer assembly.
3. Set on masonry leveling blocks prior to pour.

D. Pitch conduit properly for drainage to pull box and to prevent low pockets or irregular dips between conduit ends. Minimum pitch to be 4 inches per 100 feet.

E. Provide accurate locations of conduit in utility hole.

F. Depending on encasement necessary for duct formation, place conduits on spacers. The minimum encasement thickness 3-inches on all sides.

G. Lay conduits using spacers to provide tier spacing.

H. Make tight conduit joints by complying with recommendations of conduit manufacturer, using coupling jointing compound or PVC primer and solvent cement. All joints in conduits and fittings shall be made up tight and shall be watertight. All threaded portions of steel conduits that are not to be encased in concrete and adjoining ends of conduits, couplings and fittings, shall be heavily coated with asphaltum after installation. All connections between conduits of different types shall be made in an approved manner using adapters of other materials and methods recommended for the purpose by the conduit manufacturers.

I. Provide not more than one 90-degree bend or equivalent between pull points for primary conduit and two 90-degree bends or equivalent for signal conduit.

J. In ductbanks with both primary and signal conduit, primary conduit shall be straight and the signal conduit shall contain bends as necessary to accommodate the primary duct. Any offsets or bends shall be made in steel conduit. PVC conduit may only be used in straight lengths.

K. Provide flush bell ends on duct at utility holes. When entering a new building or a new manhole the bell ends for PVC shall be a pre-manufactured system (system as manufactured by Fomiex or equal) with conduit seals and provisions for roughing into the concrete.

L. Provide insulated, grounding bushings on duct ends in equipment enclosure.

M. Plug or cap empty conduits. Provide standard manufactured plugs.

N. Seal all spare ducts and conduits, at all new and existing building entrances and at outdoor terminations at equipment pedestals with a suitable compound to prevent the entrance of moisture and gases.

0. After ducts are in place and before the concrete is poured, the installation shall be inspected by the Engineer. Notify the Engineer at least two days before the time of inspection.

P. Clear conduit by rod and pull an approved test mandrel from structure to structure or from structure to the conduit termination.

Q. Leave nylon or polyester pull line in each conduit, tagged to identify the conduit's point of origin, contents and final destination.

R. Conduit Couplings: Conduit couplings shall be staggered so that couplings on adjacent conduits will not lie in the same transverse plane. End bells shall be spaced approximately 9 inches center to center at face of manhole wall for 4-inch conduits and proportionately spaced for other sizes. The change from regular conduit spacing to end bell spacing shall start 10 feet from the face of the manhole wall and shall be made in such a way that the slope of any conduit will not be less than that of the main bank and no trap will be formed. New conduit entrances into existing manholes and building walls shall enter at the most desirable locations consistent with grading requirements and existing entrance and shall be waterproofed in a satisfactory manner.

S. Bends: Conduit generally shall be straight between manholes or upturned elbows. Where bends are unavoidable in non-metallic conduits, they may be made by assembling couplings at a slight angle, provided the watertight seals are not broken and the resulting radius is not less than 100 feet. For radii less than 100 feet, 5-degree angle couplings or 5-degree factory-made bend sections shall be used.

1. Install top of duct bank minimum 30 inches below finished grade.

2. Terminate conduit in end bell at manhole entries.

3. Provide minimum 3-inch concrete cover at bottom, top, and sides of duct bank.

T. Multiple conduit: Install multiple conduit as follows:

1. Multiple conduit runs, direct burial or in duct bank, shall be supported on preformed, non-metallic separators. Spacing between exterior surfaces of conduits shall be as indicated on the Drawings.

   a. Spacing between separators shall be close enough to prevent sagging of conduits and breaking of couplings and watertight seals. Separators shall also be spaced to keep deformation of conduit at the separators to 0.10-inch or less. Separators shall be secured with cords where necessary and no tie wires, reinforcing rods or other metallic materials shall be placed around the conduits, either individually or in groups, in such a manner as to form a magnetic loop.

2. Multiple conduit rims shall be arranged substantially as shown on the drawings, but minor changes in location or cross sectional arrangement shall be made as necessary to avoid obstructions. Where conduit runs cannot be installed substantially as shown because of conditions not discoverable prior to digging of trenches, the condition shall be referred for instructions before further work is done. All underground conduit work shall be coordinated with other outside service work. Existing outside services shall be maintained in operation unless directed otherwise.

3.6 CONCRETE. WORK

A. Unless otherwise indicated, all concrete work for electrical handholes, ductbanks, etc., shall be provided under this section of the work. All concrete shall be minimum 3,000 psi test at 28 days. Concrete for ductwork shall be Class B. 470 lb. (5 sacks) of Portland cement per cubic yard.

B. Supervise the placement of concrete in the ductbank.

C. Complete entire section of conduit from utility hole to building, or building to building before encasement by concrete. The entire conduit system shall be tied together with wire and anchored to the bottom of the trench to prevent any movement or floating while pouring concrete.

D. Place concrete as specified in Section 033000. Top of concrete envelopes shall be not less than 24 inches below grade or as indicated on the drawings.

E. Provide minimum of 3-inches (76mm) of concrete cover over conduit at the top, bottom, and sides of the duct bank. Provide crowned top on the concrete to prevent water accumulation. At poured manholes, tie duct and manhole reinforcing steel together to provide a permanent connection.

F. Place concrete continuously without interruption.

G. Extend concrete envelope to finish floor grade or interior wall surface in buildings at finish pad grade at equipment. Maintain moisture seal.

H. Conduits in completed ductbanks shall be straight to within 1/4 inch per 100 feet in both vertical and horizontal directions.

1. Pull solid mandrels and swabs (diameter 1/4 inch smaller than conduit) through each conduit in completed ductbank before installing cables.

I. Concrete-Encased Nonmetallic Ducts: Support on plastic separators coordinated with duct size and required duct spacing, and install according to the following:

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, and secure separators to the earth and to ducts to prevent floating during concreting.

a. Do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups. Provide nonferrous tie wires to prevent displacement of the ducts during pouring of concrete.

b. Provide spacers staggered at least 6 inches vertically along the length of the duct run to eliminate the potential for a weak vertical shear plane in concrete encasements.

c. Provide a minimum of four spacers per 20-foot interval (5 feet maximum) along the length of the duct mil.

2. Concreting: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not use power-driven agitating equipment unless specifically designed for duct bank application. Pour each run of envelope between manholes or other terminations in one continuous operation. When more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (18mm) reinforcing rod dowels extending 18 inches (450 mm) into the concrete on both sides of joint near the corners of the envelope.

3. Reinforcing: Provide reinforcing steel bars at the top and bottom of each concrete envelope as shown on Drawings and at the present and indicated future locations, including but not limited to the following:

   a. Crossing fill or loose soil (4 feet beyond the exterior limits on each side).

   b. Crossing other utilities (8 feet beyond the exterior limits on each side).

   c. Entering buildings, manholes, vaults. etc. (20 feet beyond).

   d. Crossing vehicle roadways and parking areas (underneath and 20 feet beyond the exterior limits on each side).

   e. Rebar shall not be installed less than 2-inches from the sides of any duct.

   f. Under all pavement (6 feet beyond edge of pavement).

   g. Crossing soils and rock where the bottom of the trench is not undisturbed soil or the bearing is less than 3,000 psf, then the entire distance such conditions exist, plus 10 feet either side of these conditions.

4. Forms: Use the walls of the trench to form the side walls of the duct bank where the soil is self-supporting and concrete envelope can be poured without soil inclusions. Otherwise, use forms.

5. Minimum Clearances Between Ducts: Three inches (75 mm) between ducts and exterior envelope wall, 3 inches (75 mm) between ducts for like services, and 6 inches (150 mm) between power and signal ducts. Provide plastic spacers to maintain clearances.

6. Depth: Except as otherwise indicated, install top of duct bank at least 30 inches (750 min) below finished grade in non-traffic areas for 600 volts and below.

7. Install at least 30 inches (750 nun) below finished grade in vehicular traffic areas for 600 volts and above.

K. Partial Pouring: Each run of envelope between manholes shall be poured in one continuous operation. Where more than one pour is necessary, each pour shall terminate in a vertical plane, and 3/4-inch reinforcing rod dowel extending 18 inches into the concrete on each side of the joint shall be provided. The number and locations of dowels shall be as approved. Partial pours shall not terminate in horizontal or angular planes.

L. Extensive Disturbed Earth: Where an envelope is installed over an extensive area of disturbed earth, such as that within the periphery of the building, a separate 3,000 psi

concrete base, satisfactory, shall be provided to ensure stability of the conduits during installation. The base shall be allowed to set before the conduit bank is installed.

M. Obstructions Below Grade: Where an envelope is installed over disturbed earth, across other conduits or pipe lines or under roads or driveways, it shall be reinforced. Reinforcement shall also be provided where envelopes connect to manhole and building walls, to prevent shearing of the joints. Where envelopes are terminated for future extension, dowels shall be provided as specified above for joints between pours. Reinforcement, generally, shall consist of 3/4-inch rods located in a single layer 1-1/2 inches above the bottom of the envelope. Outside rods shall be located 1-1/2 inches in from the outside edges of the envelopes and an intermediate rod shall be placed in the center of each space between conduits in the lowest row. Provide No. 4 steel reinforcing bars in top of envelope under paved areas. Additional reinforcement shall be furnished as directed following an inspection of the trench.

N. Stub-Ups: Use rigid steel conduit for stub-ups to equipment. For equipment mounted on outdoor concrete pads, extend steel conduit a minimum of 5 feet (1.5m) from the edge of the pad and 5 feet outside of the building foundation. Install insulated grounding bushings on the terminations. Couple steel conduits to the ducts with adapters designed for the purpose and then encase coupling with 3 inches (75 mm) of concrete. Provide insulated grounding bushings on the terminations.

0. Above-Grade Conduit:

1. All exposed conduit rising more than one foot (I') above the adjacent grade shall be rigid steel conduit, full weight, pipe size, finished inside and outside by a hot-dipped galvanized method. Conduit shall have threaded-type couplings and fittings with insulated end bushing. Rigid steel conduit shall extend a minimum of eighteen inches (18-inches) below grade before transition to PVC conduit.

2. Provide galvanized or cadmium-plated nails, screws, clips, or other means of securely anchoring conduit to buildings or other structures as required for a complete installation. Adequate provisions shall be taken to prevent dielectric action between dissimilar metals.

P. Sealing: Provide temporary closure at terminations of ducts that are wired under this project. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15 psi (1.03 Mpa) hydrostatic pressure.

Q. Duct Entrances to Manholes and Handholes: Space end bells approximately 10 inches (250 mm) on center for 5-inch (125 mm) ducts and varied proportionately for other duct sizes. Change from regular spacing to end bell spacing 10 feet (3m) from the end bell without reducing duct line slope and without forming a trap in the line. Grout end bells into manhole walls from both sides to provide watertight entrances. Provide expansion joint material between duct and handhole.

1. Duct bank envelopes connecting to underground structures shall be flared to have an enlarged cross-section at the manhole entrance to provide additional shear strength. Dimensions of the flared cross-section shall be larger than the corresponding manhole opening dimensions by no less than 12 inches in each direction. Perimeter of the cut bank opening in the underground structure shall be flared toward the inside or keyed to provide a positive interlock between the duct bank and the wall of the structure. Use vibrators when this portion of the

encasement is placed to assure a seal between the envelope and the wall of the structure.

R. Building Entrances: Transition from underground duct to conduit 10 feet (3m) minimum outside the building wall. Use fittings manufactured for the purpose. Follow appropriate installation instructions below.

1. Concrete-Encased Ducts: Install reinforcing in ductbanks passing through disturbed earth near buildings and other excavations. Coordinate ductbank with structural design to support ductbank at wall without reducing structural or watertight integrity of building wall.

2. Waterproofed Wall and Floor Entrances: Install a watertight entrance-sealing device with the sealing gland assembly on the inside. Anchor device into masonry construction with one or more integral flanges. Secure membrane waterproofing of the device to make permanently watertight.

S. Mandrelling: After concrete envelopes have set, all conduits shall be mandrelled to ensure smooth interior surfaces free from burrs or obstructions that might damage the conductor insulation or sheaths.

3.7 CONDUIT AND DUCT INSTALLATION

A. Install nonmetallic conduit and duct as indicated according to Manufacturer's written instructions.

B. Slope: Pitch ducts a minimum of 4 inches per 100 feet (1:300) to drain toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions. Trenches shall be evenly graded so that conduits will have a uniform rate of fall of not less than 3 inches per 100 feet and will be free from either horizontal or vertical waves. Unless otherwise specified each conduit shall slope uniformly from one manhole to the next or from a high point between manholes. Low points between manholes or between upturned elbows shall be avoided wherever possible. Where it is not possible to avoid a trap or low point in a conduit which has no concrete envelope, provide a 1/2-inch hole drilled in the bottom of the conduit at the low point and a crushed stone sump of suitable volume below the conduit. If possible, install the sump above the high water table elevation for the particular location. Otherwise, provide special means to prevent the accumulation of water within the conduit.

C Curves and Bends: Use manufactured elbows for stub-ups at equipment and at building entrances. Use manufactured long sweep bends with a minimum radius of 50 feet (15 m) both horizontally and vertically at other locations.

D. Make joints in ducts and fittings watertight according to manufacturer's instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.

E. Installation of warning tapes: After lacing a minimum of 12 inches or a maximum of 18 inches of backfill over the ducts, place the appropriate warning tapes above and parallel to the centerline of the duct for the entire length of the duct trench.

F. Provided pull rope and measuring tape shall be installed at the time the mandrel is pulled through each conduit. Record the wall-to-wall measurements and the size of mandrel

used at this time. Provide this documentation to the Project Engineer on the following working day. After acceptance of these documents, the Contractor shall remove the measuring tape, leaving only the pull rope in the conduits.

G. All work and materials covered by these Specifications shall be subject to inspection at times by the Owner's designated representative. Any work concealed before it has been inspected by the Owner's designated representative shall be re-opened or uncovered and any required modification made to that portion of the work. All trenches shall be opened from manhole to manhole or manhole to building prior to laying conduit in that trench. Exceptions (such as street crossings) will be approved prior to excavation on a case-by-case basis by the Owner at a regular project meeting. These sites shall be inspected by the Owner's representative during excavation installation, backfill, restoration, and cleanup.

H. Separation distance from other buried utilities as follows:

1. Insulated Steam: 24-inches.

2. Un-insulated Steam: 48-inches.

3. All others: 18-inches.

3.8 DIRECT BURIED DUCT

A. Provide where indicated direct-buried electrical circuits utilizing either PVC Schedule 80 rigid galvanized steel conduit, as indicated. Conduit shall be as specified in Section 260533. Minimum burial depth shall be as follows:

1. Below paved roads (PVC and RGS): 30-inches below bottom of paving.
2. Under non-vehicle concrete (PVC and RGS): 30-inches below bottom of paving.
3. Other areas (PVC): 30-inches.
4. Other areas (RGS): 30-inches.

B. Minimum separation from other utilities shall be the same as for ductbanks, specified previously in the section.

C. Where feasible, and where indicated, install direct-buried lines parallel, but separated from other utility lines. Group several direct-buried conduits in a common trench where naming in the same direction, or to/from the same source. All direct-buried conduits shall have yellow plastic warning tape buried midway between the conduit and finished grade. Tape shall be the same as used for ductbanks.

D. Where direct-buried conduits penetrate walls or floor slabs, seal all spaces around conduit and fittings. Provide through-wall fittings on all wall penetrations.

E. Where an underground conduit, without a concrete envelope, enters the building through a non-waterproofed wall or floor, provide a sleeve made of Schedule 40 galvanized pipe. The space between the conduit and the sleeve shall be filled with a suitable plastic expansible compound or an oakum and lead joint on each side of the wall or floor in such a manner as to prevent entrance of moisture. A watertight entrance sealing device hereinbefore specified will be acceptable in lieu of the sleeve.

3.9 RECORD DOCUMENTS

A. Provide record set data of the actual elevation of the top of each end of each raceway or ductbank, at the midpoint, at no more than 100 foot intervals, where changes in elevation are less than 2 feet between data points or 10 foot intervals when the elevation between intervals is different by 2 feet or more between data points.

B. Provide record drawings indicating actual locations of all installed ductbanks and manholes including elevations. The record drawing shall indicate location, elevation, and type of service for all utilities crossed by new ductbank.

C. Cable Records: The Contractor shall provide a complete listing of all cables installed in each conduit and ductbank, along with all cable splice locations.

3.10 FIELD QUALITY CONTROL

A. Field inspection and testing shall be performed under provisions of Section 260501 in the presence of the Engineer.

B. Backfilling shall not be done until the concrete has cured for at least three calendar days.

C. Exposed surfaces of concrete shall be kept wet (damp) throughout the curing period.

D. Upon completion of the duct bank installation. a standard flexible mandrel shall be pulled through each duct to loosen particles of earth, sand, or foreign material left in the line. The mandrel shall be not less than 12 inches long, and shall have a diameter 1/4-inch less than the inside diameter of the duct. A brush with stiff bristles shall then be pulled through each duct to remove the loosened particles. The diameter of the brush shall be the same as, or slightly larger than, the diameter of the duct.

E. Seal the ducts and conduits at building entrances, and at outdoor terminations for equipment, with a suitable non-hardening compound to prevent the entrance of moisture and gases.

END OF SECTION 260543

SECTION 260553 - ELECTRICAL IDENTIFICATION

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 electrical identification materials and devices required to comply with ANSI C2, NFPA 70, OSHA standards, and authorities having jurisdiction.

B. This section includes labeling of all terminations and related subsystems; including, but not limited to, nameplates, stenciling, wire and cable markers, labeling and identification of cables, equipment and other products.

1.3 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Schedule of Nomenclature: An index of electrical equipment and system components used in identification signs and labels. Provide a schedule of nameplates and stenciling.

C. Samples: Prior to installation, submit samples for each type of label and sign to illustrate color, lettering style, and graphic features of identification products. These samples shall include examples of the lettering to be used. Samples shall be mounted on 8-1/2-inch x 11-inch sheets annotated, explaining their proposed use.

1.4 QUALITY ASSURANCE

A. Comply with ANSI C2.

B. Comply with NFPA 70.

C. Comply with ANSI A13.1 and NFPA 70 for color-coding.

D. Comply with applicable EIA/TIA Standards.

E. Comply with OSHA Standards.

1.5 DEFINITIONS

A. Emergency systems include, but are not limited to, generator circuits and systems, fire alarm systems, exit sign circuits, emergency lighting circuits, etc.

PART 2 - PRODUCTS

2.1 RACEWAY AND CABLE LABELS

A. Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

1. Color: Black letters on orange field.

2. Legend: Indicates voltage and service.

B. Adhesive Labels: Preprinted, flexible, self-adhesive vinyl with legend, overlaminated with a clear, weather- and chemical-resistant coating.

C. Pretensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the line it identifies and arranged to stay in place by pretensioned gripping action when placed in position.

D. Underground-Line Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape.

E. Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.

F. Plasticized Card-Stock Tags: Vinyl cloth with preprinted and field-printed legends. Orange background, unless otherwise indicated, with eyelet for fastener.

2.2 NAMEPLATES AND SIGNS

A. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.

B. Engraved Plastic Nameplates and Signs: Engraving stock, melamine 3-layer plastic laminate, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes. Use colors prescribed by ANSI A13.1, NFPA 70 and these specifications.

1. Engraved legend with white letters on black background.

2. Punched or drilled for mechanical fasteners.

3. [Emergency system nameplates shall have an engraved legend with white letters on red background, or as required by the local authority having jurisdiction.]

C. Baked-Enamel Signs for Interior Use: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for the application. 1/4-inch (6.4-mm) grommets in corners for mounting.

D. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, non-fading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for the application. 1/4-inch (6.4-mm) grommets in corners for mounting.

E. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32, stainless-steel machine screws with nuts and flat and lock washers.

2.3 UNDERGROUND LINE WARNING TAPE

A. Non-biodegradable, polyethylene tape, 8 mil thick and a minimum of 6 inches wide with detectable metallic foil. Provide warning labels on 3 foot centers and be colored as follows:

1. Electrical ducts, piping or cable (600V and below) - Yellow tape with black printed labeling: WARNING-BURIED ELECTRICAL LINE BELOW.

2. Electrical ducts, piping or cable (above 600V) - Red tape with black printed labeling: WARNING-HIGH VOLTAGE CABLE BURIED BELOW.

3. Telephone conduits or cable - Orange tape with black printed labeling: WARINGBURIED TELEPHONE LINE BELOW.

4. Fiber Optic conduits or cable - Orange tape with black printed labeling: WARING-BURIED FIBER OPTIC LINE BELOW.

5. Cable TV(CATV) conduits or cable - Orange tape with black printed labeling: WARNING-BURIED CABLE TV LINE BELOW.

B. Where two (2) or more services share a common ductbank, i.e. telephone and fiber optic, warning tape for each service shall be installed above each service's respective conduit(s).

C. Bury marker tape 12-inches below grade above every ductbank and buried conduit.

2.4 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.

1. Minimum Width: 3/16 inch (5 mm).

2. Tensile Strength: 50 lb (22.3 kg) minimum.

3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

4. Color: According to color-coding.

B. Paint: Formulated for the type of surface and intended use.

1. Primer for Galvanized Metal: Single-component acrylic vehicle formulated for galvanized surfaces.

2. Primer for Concrete Masonry Units: Heavy-duty-resin block filler.

3. Primer for Concrete: Clear, alkali-resistant, binder-type sealer.

4. Enamel: Silicone-alkyd or alkyd urethane as recommended by primer manufacturer.

C. Stenciling: Use black paint. Emergency system stenciling shall use red paint.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Where mixed voltages are used in one building (e.g., [4160 volts,] 480 volts, 208 volts), each switch, [switchboard], junction box, equipment, etc., on each system must be labeled for voltage in addition to other requirements listed herein.

2. All branch circuit and power panels must be identified with the same symbol used in the circuit directory in the main distribution center.

3. Before attaching labels, clean all surfaces with the label manufacturer's recommended cleaning agent.

4. Install all labels firmly, as recommended by the label manufacturer.

5. Labels attached to receptacle and switch data or Communication patch panels and faceplates shall be installed plumb and neatly on all equipment.

6. Install nameplates parallel to equipment lines.

7. Secure nameplates to equipment fronts using screws or rivets. Secure nameplate to inside of recessed panelboards in finished locations.

8. Embossed tape will not be permitted for any application.

9. Stenciling may only be used on equipment fronts in unfinished areas or in areas designated by the Architect/Engineer.

10. Labels: All labels shall be permanent and be machine-generated. NO HANDWRITTEN OR NON-PERMANENT LABELS SHALL BE ALLOWED.

11. Label size shall be appropriate for the conductor cable size(s), outlet faceplate layout and patch panel design. All labels to be used shall be self-laminating, white/transparent vinyl and be wrapped around the cable sheath. Flag type labels are not allowed. The labels shall be of adequate size to accommodate the circumference of the cable being labeled and properly self-laminated over the full extent of the printed area of the label.

B. Panelboard and Load Center Directories: Typed directories for panels must be covered with clear plastic, have a metal frame, and should be spelled out in Specifications. Room numbers on directories shall be Owner's numbers, not plan numbers, unless Owner so specifies.

1. Panelboards shall be equipped with equipment nameplates as specified in paragraph "Equipment Identification Labels" in Part 3 of this Section.

2. Panelboards shall have an accurate typed index indicating exactly what each added branch serves.

3. The Contractor shall provide up to date directories in new panelboards and load centers, indicating all deletions and additions, and to note the date of all changes on the directory.

4. The directory shall reflect the actual room numbers exact circuit designations. Directories indicating the reference room numbers on the contract drawings or in the panelboard schedule shall not be acceptable.

5. If at anytime, after occupancy, the directory is found to be incorrect due to negligence by the installer, then the Contractor shall trace out circuits, and correct the directory at no additional cost to the Owner.

C. Miscellaneous Identification:

1. Individual circuit breakers, switches, and motor starters in panelboards, switchboards, and motor controllers: 1/4-inch (6 mm); identify circuit and load served, including location.

2. Individual circuit breakers, enclosed switches, and motor starters: 1/4-inch (6 mm); identify load served, including location.

3. Junction boxes: 1/2-inch (13 mm); identify system source(s) and load(s) served.

D. Identification Materials and Devices: Install at locations for most convenient viewing without interference with operation and maintenance of equipment.

E. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout Project.

F. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work.

G. Self-Adhesive Identification Products: Clean surfaces before applying.

H. Circuits with More Than 600 V: Identify raceway and cable with *DANGER—HIGH VOLTAGE* in black letters 2 inches (51 mm) high, stenciled with paint at 10-foot (3-m) intervals over a continuous, painted orange background. Identify the following:

1. Entire floor area directly above conduits running beneath and within 12 inches (305 mm) of a basement or ground floor that is in contact with earth or is framed above unexcavated space.

2. Wall surfaces directly external to conduits concealed within wall.

3. All accessible surfaces of concrete envelope around conduits in vertical shafts, exposed in the building, or concealed above suspended ceilings.

4. Entire surface of exposed conduits.

I. Install painted identification according to manufacturer's written instructions and as follows:

1. Clean surfaces of dust, loose material, and oily films before painting.

2. Prime surfaces using type of primer specified for surface.

3. Apply one intermediate and one finish coat of enamel.

J. Color Code Banding and Painting of Raceways, Boxes, and Cables: Band all exposed and concealed accessible raceways, pull boxes, and junction boxes of the systems listed below:

1. Bands: Pre-tensioned, wraparound plastic sleeves; colored adhesive tape; or a combination of both. Make each color band 2 inches (51 mm) wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side.

2. Band Locations: At changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

3. Junction boxes, pull boxes, and their covers shall be distinctively painted to identify their service.

4. Apply the following colors to the systems listed below:

a. Fire Alarm System: Red.

b. Fire-Suppression Supervisory and Control System: Red and yellow.

c. Combined Fire Alarm and Security System: Red and blue.

d. Security System: Blue.

e. CCTV System: Green and yellow.

f. Mechanical and Electrical Supervisory System: Green and blue.

g. Telecommunication System: Green.

h. CATV System: Violet.

i. Computer Data: Blue.

j. 120/208 V (or 120/240 V) Power and Lighting System: Yellow.

k. 480/277 V Power and Lighting System: Black.

1. Standby/Emergency Power System: Orange.

m. Any other system, with system type (such as *Sound System)* marked on covers in black letters with white covers.

K. Caution Labels for [Indoor] Boxes and Enclosures for Power [and Lighting]: Install pressure-sensitive, self-adhesive labels identifying system voltage with black letters on orange background. Install on exterior of door or cover. Install label on inside face of door or cover in finished spaces.

L. Circuit Identification Labels on Boxes: Install labels externally.

1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover.

2. Concealed Boxes: Plasticized card-stock tags.

3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.

M. Paths of Underground Electrical [and Communication (Fiber Optic)] Lines: During trench backfilling, for exterior underground power, control, signal, and communication lines, install continuous underground line warning tape located directly above line at 12 inches (150 to 200 mm) below finished grade. Where width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches (400 mm) overall, use a single line marker. Install line marker for underground wiring, both direct-buried cables and cables in raceway.

N. Secondary Service, Feeder, and Branch-Circuit Conductors: Impregnated color-code throughout the secondary electrical system. The following color code convention(s) shall be used except where existing systems have established another color code convention. Refer to Section 260519 Conductors and Cables 3.3 Section.

1. Color-code 208 /120-V system as follows:

a. Phase A: Black.

b. Phase B: Red.

c. Phase C: Blue.

d. Neutral: White.

e. Ground: Green.

2. Color-code 480/277-V system as follows:

a. Phase A: Brown.

b. Phase B: Orange.

c. Phase C: Yellow.

d. Neutral: White with a colored stripe or gray.

e. Ground: Green.

3. Factory impregnated color the entire length of conductors, refer to Section 260519:

a. Colored cable ties applied in groups of three ties of specified color to each wire at each terminal or splice point starting 3 inches (76 mm) from the terminal and spaced 3 inches (76 mm) apart. Apply with a special tool or pliers, tighten to a snug fit, and cut off excess length.

0. Power-Circuit and Control Wire Identification: Metal tags or aluminum, wraparound marker bands for each conductor, cables, feeders, and power circuits in vaults. panelboard gutters, outlet boxes, junction boxes, pullboxes, junction boxes, manholes, switchboard rooms, and at load connections. Identify with branch circuit or feeder number for power and lighting circuits and with control wire number as indicated on equipment manufacturer's shop drawings for control wiring.

1. Legend: 1/4-inch- (6.4-mm-) steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.

2. Tag Fasteners: Nylon cable ties.

3. Band Fasteners: Integral ears.

P. Apply identification to conductors as follows:

1. Conductors to be Extended in the Future: Indicate source and circuit numbers.

2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color-coding to identify circuits' voltage and phase.

3. Multiple Control and Communication Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding, or cable marking tape.

Q. Apply warning, caution, and instruction signs as follows:

1. Warnings, Cautions, and Instructions: Install to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.

2. Emergency Operation: Install engraved laminated signs with white legend on red background with minimum 3/8-inch- (9-mm-) high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

R. Equipment Identification Labels: Engraved plastic laminate with white lettering on black background. Install on each unit of equipment, including central or master unit of each system. This includes power, lighting, communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Unless otherwise noted, labels/nameplates shall identify equipment designation(s), voltage rating, and source (including source locations). Labels for disconnect switches, motor starters, etc..., shall indicate the designation of the load served as the "equipment designation". In general, labels requiring one or two lines of text shall be 1-1/2 inches high. Labels requiring three lines of text shall be 2 inches high. The first line of text, which shall indicate equipment designation/load served, shall utilize 1/2 inch high lettering. Remaining lines of text, which shall indicate voltage ratings and source information shall utilize 1/4 inch high lettering. Refer to the Drawings for labeling examples. Apply labels to each unit of the following categories of equipment using mechanical fasteners:

1. Panelboards.

2. Electrical Switchboards.

3. Transformers.

4. Disconnect Switches.

5. Enclosed Circuit Breakers.

6. Motor Starters.

7. Push-Button Stations.

8. Contactors.

9. Electrical Cabinets and Enclosures.

10. Control Devices.

11. Fire Alarm Master Station or Control Panel.

12. Security-Monitoring Master Station or Control Panel.

13. Access Doors and Panels for Concealed Electrical Items.

S. Conduits Containing Electrical Feeders:

1. All conduits containing electrical feeders shall be identified with W.H. Brady B-500 vinyl cloth pipe markers or equivalent. Systems shall be identified as follows:

   a. Labels shall be applied whenever a conduit enters or leaves a switchboard, panelboard, or a junction or pull box, and at each side of penetrations of walls or floors.
   b. Apply Y-35 series individual numbers and letters to indicate feeder number followed by feeder voltage.
   c. At each end of the above series of markers provide a pipe banding tape around the conduit. Refer to paragraph "Color Code Banding and Painting of Raceways, Boxes, and Cables" in Part 3 of this Section for banding requirements.

T. Communication Conduit and Cables

1. Cables shall be identified with Brady B-500 vinyl cloth markers or equivalent by L.E.M., Stranco, or Panduit wire markers. Conduit shall be identified with Brady Vinyl Cloth B-500 pipe markers or equivalent. Systems shall be identified as follows:

   a. Each cable shall be identified at each point of entrance to or exit from a conduit or enclosure and at 50-foot intervals in the tray. All identification at 50-foot intervals shall *be* at the same location in the tray. Each cable shall be identified at control panels, junction boxes, and terminal boards.

   b. Conduit shall be identified exiting an enclosure or panel at junction or pull boxes, and at each side of penetrations of walls, partitions, or floors, within 1-foot of penetration to identify service type, i.e. "TELEPHONE", "DATA", "CATV", etc...

U. Fire Alarm: Junction box covers shall be painted red. Wiring color code shall match existing. Coordinate color with Owner otherwise, wiring color code shall be as follows:

1 .	Red-	Smoke Detector - Common.
2 .	Black	Smoke Detector - Power.
3 .	Yellow-	Smoke Detector - Alarm.
4 .	Orange	Heat Detector - Alarm.
5 .	Pink-	Flow Switch.
6 .	Tan-	Valve Tamper Switch.
7 .	Purple-	Bells.
8 .	Grey-	Audio/Visual Devices.

9 . Light Blue- Manual Stations.

V. Provide NEC, ANSI, and OSHA-approved *DANGER - HIGH VOLTAGE* warning signs on all doors of dedicated electrical rooms or closets. Where doors are located in finished areas, locate sign on the inside of the door. Coordinate mounting requirements with the Engineer. Minimum sign dimension shall be 15-inch x 11-inch.

W. Surfaces shall be cleaned and painted, if specified, before applying markings.

X. Place markings so that they are visible from the floor.

Y. Protect finished identification to insure that markings are clear and legible when project is turned over to the Owner.

END OF SECTION 260553

SECTION 260573 - ANALYSIS AND COORDINATION STUDY

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. An Engineering Analysis and Coordination Study shall be performed on and include all portions of the electrical distribution system. The analysis shall include a short-circuit analysis with protective device evaluation, a protective device coordination study, time-current analysis of each protective device, and equipment evaluation study.

B. [The existing electrical equipment, panelboards and devices which are to be reused shall be surveyed and a determination made as to the adequacy of their short circuit rating with regard to the available short circuit currents.]

C. A one-line diagram of the system shall also be included. The final report shall be bound in a three-ring binder.

1.3 SCOPE OF PROJECT

A. The project shall begin at the new incoming utility service to the facility, continue through the facility's electrical distribution system, including, but not limited to the following: switchboard, distribution panelboards, transformers, **[motor control centers,]** and lighting and appliance panelboards.

B. The scope includes all existing electrical distribution system equipment and feeders.

C. The scope includes the emergency/standby power distribution system equipment and feeders.

1.4 PREPARER

A. Engineering Analysis and Coordination Study shall be performed by one of the following organizations, or an approved and qualified equal:

1. Cable Testing Services, Inc.
1212 Calvert Road
North East, MD 21901
Telephone: 302-369-
5420 Toll-Free: 1-800-
824-1600 Fax: 302-369-
5515

Contact: Charles Emery, PE

2. AB Engineering LLC
   303 Dressage Court
   West Chester, PA 19382
   Telephone: 610-765-1290
   Contact: Alton Baum, PE

3. Potomac Testing, Inc.
   1610 Professional Blvd, Suite A
   Crofton, MD 21114
   Telephone: 301-352-1930
   Toll-Free: 1-800-331-2022
   Contact: John F. Mayan, PE

4. Coordinated Power Engineering, Inc.
   1340-G Charwood
   Road Hanover, MD
   21076
   Telephone: 410-694-9494
   Fax: 410-694-0085
   Contact: Carl E. Rager, PE

1.5 SHORT-CIRCUIT ANALYSIS WITH PROTECTIVE DEVICE EVALUATION

A. Systematically calculate fault currents based on the available fault current at the facility service entrance. Study preparer shall obtain the available fault current from the local utility.

B. Short-circuit calculations shall be prepared by means of a digital computer utilizing a commercially available software package. Motor contribution shall be incorporated in determining fault levels. Results of short-circuit calculations shall be presented in tabular form and shall include momentary interrupting fault values for three-phase and phase-to-ground faults.

C. Analyze the short-circuit currents by preparing a tabulation comparing the fault levels to the device interrupting ratings. Indicate areas in which integrated/series ratings are utilized. The following information shall be included in the tabulation:

1. Bus identification number.

2. Location identification.

3. Voltage.

4. Manufacturer and type of equipment.

5. Device rating.

6. Calculated short-circuit current.

1.6 PROTECTIVE DEVICE COORDINATION STUDY

A. Prepare coordination time-current characteristic curves to determine the required settings/sizes of the protective devices to maximize selectivity. The utility upstream protective device feeding the facility shall be maintained as the upper limit for Coordination. These settings shall be obtained by the preparer, along with any other protective device setting requirements. The Coordination curves shall be prepared on log-log paper and illustrate adequate clearing times between series devices. The curves may be hand-drawn or created through the use of a computer, but must reflect actual protective devices to be installed. Adequate time-current curves shall be generated to depict coordination. In addition, protective device characteristics shall be suitably determined to reflect calculated short-circuit levels at that location.

B. A narrative analysis shall accompany each Coordination curve sheet and describe the Coordination and protection in explicit detail. All curve sheets shall be multi-color for improved clarity. Areas lacking complete Coordination shall be highlighted and reasons provided for allowing condition to remain or provide solution to resolve situation. System Coordination, recommended ratings, and setting of protective devices shall be accomplished by a registered professional electrical engineer with a minimum of two years of current experience in the coordination of electrical power systems.

C. The following information shall be provided on all curve sheets:

1. Device identification and associated settings/size.

2. Voltage at which curves are plotted.

3. Current multiplier.

4. ANSI frequent fault damage curve.

5. Cable insulation damage curves.

6. Transformer inrush point.

7. Single-line for the portion of the system.

D. Coordination shall be in accordance with requirements of the *National Electrical Code* and the recommendations of the IEEE Standard 399.

1.7 LOAD FLOW AND VOLTAGE DROP ANALYSIS

A. The Load Flow and Voltage Drop Analysis shall be made using a digital computer and shall include calculations of power flow in all three phase branch and feeder circuits, calculated voltages at each bus and voltage drops of each feeder.

B. The analysis shall provide the calculated maximum values of kVA, kW, kVAs, power factor and amperes for each power circuit.

C. The calculated power losses in each branch and total system losses shall be provided.

D. A computer printout listing of all cables, transformers, loads, and other circuit data shall be included.

E. Provide tabular bus-to-bus computer printouts listing the calculated values.

F. The analysis shall include a computer-generated system one-line diagram clearly identifying individual equipment buses, bus numbers, cable and bus connections, power flow throughout the system, and other information related to the analysis.

G. A discussion section evaluating the loading and voltage levels for the system shall be provided and recommendations included as appropriate to improve system operation.

H. Significant deficiencies in loading or voltage levels shall be called to the attention of the Engineer (Architect) and recommendations made for improvements as soon as they are identified.

1.8 POWER FACTOR CORRECTION STUDY

A. A Power Factor Correction Study shall be performed to determine the appropriate level of compensation needed to achieve the desired power factor.

B. Impacts on harmonic and transient concerns shall be evaluated in order to determine the optimum size and configuration of the equipment.

C. The study shall make appropriate recommendations in order to provide proper operation of the electrical system.

D. The study shall be based on (load data collected from on-site measurements) (load data collected from historical information provided by the power monitoring system) (from previous utility bills) in order to characterize the power factor for the system over a period of time and under varying load conditions.

E. System loading tables shall be provided which include power factor data and estimated levels of power factor compensation provided.

F. Evaluation of system operation using the estimated levels of compensation will be provided with consideration to harmonic and transient concerns.

G. Final levels of compensation will be determined and used as the base case condition for the harmonic and transient studies.

H. All conclusions, recommendations, and equipment Specifications as a result of the Power Factor Correction Study will be summarized in the final report.

1.9 HARMONIC ANALYSIS STUDY

A. A Harmonic Analysis Study shall be made to determine the levels of harmonic voltages and currents in the system.

B. The type and level of compensation needed to achieve the desired power factor and acceptable levels of harmonics shall be considered.

C. Transient concerns shall be evaluated in order to determine the optimum equipment size, location in the system, and configuration.

D. The study shall make appropriate recommendations in order to provide proper protection and operation of the electrical system.

E. The study will be based on (load data collected from on-site measurements) (load data collected from historical information provided by the power monitoring system) (from previous utility bills) in order to characterize the power factor of the system over a period of time and under varying load conditions.

F. Harmonic measurements will be performed in order to provide nonlinear load (e.g., DC drive) characteristics, voltage distortion levels, and model verification. The measurements will be conducted over a 1-5 day period.

G. Harmonic source models will be developed for each nonlinear load (drive, etc.) type. The load characteristics (will be determined by measurement and used as harmonic sources for the computer simulations) (shall be approximated based on the loads indicated on the project drawings).

H. Frequency scan cases (impedance vs. Frequency) will be completed in order to determine the system frequency response characteristic for various system conditions.

I. If required, the application of harmonic filters will be evaluated to determine the optimum filter size and configurations.

J. Computer simulations shall be performed to determine the system harmonic voltage and current levels and voltage distortion levels (and compared with measured values to determine the effect of various system conditions).

K. If required, harmonic filter Specifications shall be developed with consideration to cost, filtering options, and effectiveness of harmonic filters.

1.10 SWITCHING TRANSIENT ANALYSIS STUDY

A. A Switching Transient Analysis Study shall be made to determine the transient overvoltages for various switching conditions and their effect on the operation of the electrical system.

B. Various system conditions (consistent with previously gathered data from the Power Factor Correction Study and Harmonic Analysis Study) shall be evaluated so that the proper overvoltage protection specifications may be developed.

C. Transient simulations shall be performed using a digital computer in order to determine transient voltage levels at the low voltage buses within the electrical system.

D. The electrical system parameters shall be varied in order to determine their effect on the

transient voltages.

E. Various solutions to excessive transient voltage levels shall be considered and additional computer simulations made to determine their validity.

F. The evaluation must consider solutions to power factor and harmonic concerns with respect to transient overvoltage levels.

G. Nuisance tripping of electronic power equipment (e.g., adjustable speed drives) shall be evaluated and corrective or preventative techniques suggested.

1.11 MOTOR STARTING STUDY

A. A motor starting study shall be performed to determine severity of voltage dips and adequacy of load accelerating torque when starting large motors on the system.

1.12 SINGLE-LINE DIAGRAM

A. The final report shall include a multi-color single-line diagram of the electrical distribution system within the scope of the project. The single-line diagram shall include:

1. Transformer rating, voltage ratio, impedance, and winding connection.

2. Feeder cable phase, neutral and ground sizes, length of cable, conductor material, and conduit size and type.

3. Switchgear, switchboards, fuses, circuit breakers, and switches continuous current ratings.

4. Protective relays with appropriate device numbers and CT's and PTs with associated ratios.

5. Detailed legend indicating device type identification and other significant details.

1.13 QUALITY ASSURANCE

A. Preparer Qualifications: Firm experienced in the analysis, evaluation, and Coordination of electrical distribution systems and similar to the system for this project. Firm must have a record of successful in-service performance, for a minimum of five (5) years.

B. The Study shall be prepared in accordance with the latest edition of NETA Std. ATS, NFPA 70 *National Electrical Code,* ANSI C2 *National Electrical Safety Code,* and ANSI/IEEE Guidelines, as well as manufacturer's recommendations.

C. Analysis and Coordination Study shall be performed by a registered [State of Maryland] Professional Electrical Engineer. Study shall be signed and sealed by the Engineer.

1.14 APPLICABLE REFERENCES

A. ANSI/IEEE Std. 142-1991. IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems (IEEE Green Book).

B. ANSI/IEEE Std. 241-1990. IEEE Recommended Practice for Electric Power Systems in Commercial Buildings (Gray Book).

C. ANSI/IEEE Std. 242-1986. IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (Buff Book).

D. ANSI/IEEE Std. 399-1990. IEEE Recommended Practice for Power Systems Analysis (Brown Book).

E. ANSI/IEEE Std. 400-1991. IEEE Guide for Making High-Direct-Voltage Tests on Power Cable Systems in the Field.

F. ANSI/IEEE Std. 446-1987. IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications (Orange Book).

G. ANSUIEEE Std. 493-1990. IEEE Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems (Gold Book).

H. ANSI/IEEE Std. 602-1986. IEEE Recommended Practice for Electric Systems in Health Care Facilities (White Book).

I. ANSI/IEEE Std. 739-1984. IEEE Recommended Practice for Energy Conservation and Cost-Effective Planning in Industrial Facilities (Orange Book).

J. ANSI/IEEE Std. 1100-1992. IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment (Emerald Book).

K. Insulated Cable Engineers Association - ICEA.

L. International Electrical Testing Association - NETA. NETA Maintenance Testing Specifications for Electrical Power Distribution Equipment and Systems.

M. National Electrical Manufacturer's Association - NEMA.

1. NEMA Standard for Publication No. AB4-1991: Guidelines for Inspection and Preventive Maintenance of Molded-Case circuit Breakers Used in Commercial and Industrial Applications.

2. NEMA Publication MG1: Motors and Generators.

N. National Fire Protection Association - NFPA:

1. ANSI/NFPA 70: National Electrical Code.

2. ANSUNFPA 70B: Recommended Practice for Electric Equipment

Maintenance.

3. ANSUNEPA 70E: Electrical Safety Requirements for Employee Workplaces.

4. ANSI/NFPA 99: Standard for Healthcare Facilities.

5. ANSI/NFPA 101: Life Safety Code.

6. ANSUNEPA 110: Emergency and Standby Power Systems.

7. ANSUNFPA 780: Lightning Protection Code.

0. Occupational Safety and Health Administration - OSHA.

P. State and local codes and ordinances.

Q. Underwriters Laboratory - UL.

1.15 LEED REQUIREMENTS

A. Refer to Division 1 Section LEED Requirements for description of work under this Division affected by LEED requirements.]

PART 2 -PRODUCTS

2.1 SUBMITTALS

A. General: Submit the following according to Conditions of the Contract and Division 1 Specification Sections: Submit for review six (6) copies of a Protection Coordination Study.

B. Shop Drawings for equipment affected by the Coordination Study will not be reviewed until the Coordination Study has been submitted and approved.

C. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include list of completed projects with project names, addresses, names of Engineer and Owner, and other information specified.

PART 3 - EXECUTION

3.1 IMPLEMENTATION:

A. The Contractor shall engage an independent testing firm for the purpose of inspecting, setting, testing, and calibrating the protective relays, circuit breakers, fuses, and other applicable devices as recommended in the Analysis and Coordination Study Report.

B. The Contractor shall provide all necessary factory and field settings, adjustments, and minor modifications, for conformance with the Study.

3.2 FIELD SURVEYS, MEASUREMENTS AND INVESTIGATIONS

A. The Contractor shall examine the site, determine all conditions and circumstances and gather all data and information required for work.

B. The Contractor shall survey all new and existing equipment and devices. Data gathering shall include, but not be limited to, equipment nameplate information, ratings, voltage, impedance, wiring configurations, conductor lengths, conductor routing, conductor sizes, and other information as required for a complete study.

C. The Contractor shall provide complete field investigations to determine existing and new device and equipment manufacturer, type, ampacity, voltage, rating, setting, limits, nameplate, sizes, taps, ratios, impedance, trips, and configurations.

D. The Contractor shall assume that all information shall be obtained from field surveys and not from Owner's records. If Owner's records are made available to the Contractor, for information only, the Contractor shall verify the Owner's Records with the existing conditions.

E. Field investigations include, but are not limited to, performing manhole surveys, opening of equipment enclosures, and other work as required for a complete study.

END OF SECTION 260573

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes time[**clocks, photoelectric relays, and multipole lighting relays and contactors].**

B. Related Sections include the following:

1. Division 16 Section, "Wiring Devices" for wall-box dimmers and manual light switches.

2. Division 16 Section, "Occupancy Sensors" for wall-mounted and ceiling-mounted occupancy sensors.

1.3 SUBMITTALS

A. Product Data: Include dimensions and data on features, components, and ratings for lighting control devices. Provide product data on each control device specified.

B. Schedule: Prepare, and submit a contactor and relay schedule. Include the following information in the schedule:

1. Contactor identification

2. Operator Type (Mechanical or Electrical)

3. Contact Configuration and Rating

4. Circuit Numbers Controlled

5. Enclosure Rating

6. Control Circuit

7. Voltage

8. Location

C. Samples: Occupancy sensors for color selection and evaluation of technical features.

D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

E. Shop Drawings: Indicate control device enclosure wiring diagrams and panel layout drawings.

F Maintenance Data: For lighting control devices to include in maintenance manuals specified in Division 1. Include instructions on adjusting, repairing, cleaning and lubricating each control device specified.

G. Project Record Documents: Accurately record actual locations of each product and device, and indicate circuits controlled.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain lighting control devices from a single source with total responsibility for compatibility of lighting control system components specified in this Section.

B. Electrical Components. Devices and Accessories: Listed and labeled as defined in NFPA-70, Article 100, for their indicated use and installation conditions by a testing agency acceptable to authorities having jurisdiction.

C. Comply with 47 CFR 15, Subparts A and B, for Class A digital devices.

D. Comply with NFPA 70.

E. Comply with NEMA. ICS 2, *Industrial Control Devices, Controllers and Assemblies.*

F. Comply with UL 773A, *Non-Industrial Photoelectric Switches for Lighting Control.*

G. Comply with ANSI/NEMA ICS 6, *Enclosures for Industrial Controls and Systems.*

1.5 COORDINATION

A. Coordinate features of devices specified in this Section with systems and components specified in other Sections to form an integrated system of compatible components. Match components and interconnections for optimum performance of specified functions. Include coordination with the following:

1. Division 16 Section, "Panelboards".

2. Division 16 Section, "Interior Lighting".

3. Division 16 Section, "Exterior Lighting".

4. Division 15 Section, "Automatic Temperature Control".

1.6 [LEED REQUIREMENTS

A. **Refer to Division 1 Section "LEED Requirements" for description of work under this Division affected by LEED requirements.]**

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Time Clocks:

    a. Diversified Electronics, Inc.

    b. Grasslin Controls Corp.

    c. Intermatic, Inc.

    d. Leviton Manufacturing.

    e. Paragon Electric Co., Inc.

    f. Tork, Inc.

    g. Zenith Controls, Inc.

2. Photoelectric Relays:

    a. Allen-Bradley/Rockwell Automation.

    b. Area Lighting Research, Inc.

    c. Fisher Pierce.

    d. Grasslin Controls, Corp.

    e. Intermatic, Inc.

    f. Paragon Electric Co., Inc.

    g. Rhodes: M H Rhodes, Inc.

    h. SSAC, Inc.

    i. Tork, Inc.

3. Contactors and Relays:

    a. Automatic Switch Co.

    b. Challenger Electrical Equipment Corp.

c. Cutler-Hammer Products; Eaton Corporation.

d. Furnas Electric Co.

e. GE Lighting Controls.

f. Hubbell Lighting, Inc.

g. Siemens Energy and Automation, Inc.

h. Square D Co.; Power Management Organization.

i. Zenith Controls, Inc.

4. Emergency Transfer Relays

a. Bodine

b. IOTA Engineering

c. Nine 24, Inc.

d. Side-Lite

2.2 GENERAL LIGHTING CONTROL DEVICE REQUIREMENTS

A. Line-Voltage Surge Protection: Include in all 120- and 277-V solid-state equipment. Comply with UL 1449 and with ANSI C62.41 for Category A locations.

2.3 TIME CLOCKS:

A. Description: Solid-state programmable units with alphanumeric display complying with UL 917.

B. Description: Electromechanical-dial type complying with UL 917.

1. Astronomic dial.

2. Two contacts (Class A150, SPST), rated 30 A at 277-V ac, unless otherwise indicated.

3. Two pilot-duty contacts, rated 2 A at 240-V ac, unless otherwise indicated.

4. Eight-day program uniquely programmable for each weekday and holidays.

5. Skip-day mode.

6. **[Permanent schedule retention during power outage and leap year compensation.]**

C. Cabinet: Install system components in NEMA 1 type hinged lockable enclosure.

Provide NEMA Type 4 for outdoor applications.

2.4 TIME CLOCKS-ELECTROMECHANICAL

A. Description: Electromechanical dial-type complying with UL 917 with the following features:

1. Twenty-four (24) hour dial and day-omitting device.

2. Shall be self-powered by a self-starting synchronous motor.

3. Contacts shall be capable of switching 40 amperes per pole continuously at 277 volts, and shall be SPST, SPDT, DPST, or DPDT as required.

4. Removable ON-OFF trippers shall make possible automatic operation with a minimum "ON" period of twenty (20) minutes and a minimum two (2) hours between one "OFF" period and the next.

5. Enclosure shall be NEMA 1, surface-mounted, with combination $^{1}/2$" and $^{3}/4$" knockouts on bottom, both sides, and back.

6. Provisions for positive padlocking.

7. Terminals shall be capable of receiving #8 AWG wire.

8. Reserve Power Unit: Spring-driven reserve shall be provided sufficient to operate contacts at least sixteen (16) hours after power failure. On restoration of power, time clock shall transfer to synchronous motor drive and automatically rewind reserve power unit.

B. Time Clock shall be TORK Model 7200L, or approved equal by listed manufacturer.

2.5 PHOTOELECTRIC RELAYS

A. Description: Solid state, with single-pole, double-throw dry contacts rated to operate connected relay or contactor coils or microprocessor input, and complying with UL 773A. Contacts shall be fail-safe control so that load will remain "ON" in case of cell failure. Contact shall be rated for Class A150.

B. Light-Level Monitoring Range: 0 to 3500 fc (0 to 37,673 lx), with an adjustment for turn-on/turn-off levels.

C. Time Delay: Prevents false operation.

D. Indoor Ceiling- or Wall-Mounting Units: Adjustable for turn-on/turn-off levels, semiflush, calibrated to detect adequacy of daylighting in perimeter locations, and arranged to turn artificial illumination on and off to suit varying intensities of available daylighting.

E. Indoor Skylight Units: Housed in a threaded plastic fitting for mounting under

skylight.

F. Outdoor Sealed Units: Weathertight housing, resistant to extreme temperatures (-30 degrees F to +158 degrees F) and equipped with sun-glare shield and ice preventer.

2.6 OUTDOOR PHOTOCELLS

A. Description: Specification Grade photocell with the following features:

1. Constructed of die-cast zinc, gasketed for weather protection.

2. Cell shall be cadmium sulphide, epoxy coated, one inch diameter.

3. Unit shall have a slide for earlier or later turn on.

4. Delay of up to two (2) minutes to prevent false switching due to light from vehicles of lightning, etc...

5. Contacts shall be normally closed and fail in the "ON" position.

6. Temperature Range: -40 degrees to +140 degrees Fahrenheit.

7. Provided with three (3) color-coded, minimum six (6) inch long wire leads, #16 AWG, rated for 105 degrees Celsius.

8. Photocell shall have a fixed base for mounted through 7/8 inch opening or V2 inch knockout.

B. Photocell shall be TORK Model 2101, or approved equal by listed manufacturer.

2.7 MULTIPOLE CONTACTORS AND RELAYS

A. Description: Electrically operated and mechanically held, and complying with UL 508 and NEMA ICS 2.

1. Current Rating for Switching: UL listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballasts with 15 percent or less total harmonic distortion of normal load current).

2. Control Coil Voltage: Match control power source.

3. Provide fused control power transformer for each contactor as required by power
source.

2.8 MANUAL CONTROL STATIONS

A. Maintain contact (keyed) two-wire device.
B. Two-Position Illuminated Selector Switch: Heavy duty, 10 amp, continuous, 277 volt.

C. Pushbutton On/Off Switch with Indicating Lights: NEMA ICS 2, heavy duty type.

2.9 EMERGENCY TRANSFER RELAYS (ETR)

A. Emergency transfer relays shall be double pole. Double throw with continuous duty rated coil in a NEMA **1** enclosure.

1. Units for individual lighting fixtures shall have contacts rated minimum 2.8 Ampere, 120/277 volt dual voltage input and be U. L. 924 listed.

2. All other units shall have contact rated minimum 20 amperes, 120/277 volt dual voltage input and all U. L. 924 listed.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install equipment level and plumb and according to manufacturer's written instructions.

B. Mount lighting control devices according to manufacturer's written instructions and requirements in Division 16 Section, "Common Work Results for Electrical".

C. Mounting heights indicated are to bottom of unit for suspended devices and to center of unit for wall-mounting devices.

D. All products and devices shall be installed in accessible locations.

E. Locate electrically held contactors where the eventual vibration and noise they will produce will not be objectionable to building occupants.

F. Provide enclosures for each individual component.

3.2 CONTROL WIRING INSTALLATION

A. Install wiring between sensing and control devices according to manufacturer's written instructions and as specified in Division 16 Section, "Conductors and Cables" for low-voltage connections **[and Division 16 Section, "Voice and Data Systems"]** for digital circuits.

B. Wiring Method: Install all wiring in raceway as specified in Division 16 Section, "Raceway and Boxes", unless run in accessible ceiling space and gypsum board partitions.

C. Bundle, train, and support wiring in enclosures.

D. Ground equipment.

E. Connections: Tighten electrical connectors and terminals according to manufacturer's

published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

F. Connect control devices to systems controlled, to achieve proper system operation.

3.3 IDENTIFICATION

A. Identify components and power and control wiring according to Division 16 Section, "Electrical Identification".

3.4 FIELD QUALITY CONTROL

A. Schedule visual and mechanical inspections and electrical tests with at least seven days' advance notice.

B. Inspect control components for defects and physical damage, testing, laboratory labeling, and nameplate compliance with the Contract Documents.

C. Check tightness of electrical connections with torque wrench calibrated within previous six months. Use manufacturers' recommended torque values.

D. Verify settings of photoelectric devices with photometer calibrated within previous six months.

E. Electrical Tests: Use particular caution when testing devices containing solid-state components. Perform the following according to manufacturer's written instructions:

1. Continuity tests of circuits.

2. Operational Tests: Set and operate devices to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions. Include testing of devices under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.

F. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.

G. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.

H. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

3.5 CLEANING

A. Cleaning: Clean equipment and devices internally and externally using methods and materials recommended by manufacturers, and repair damaged finishes.

3.6 [DEMONSTRATION

A. **Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:**

1. **Train Owner's maintenance personnel on troubleshooting, servicing, adjusting, and preventive maintenance. Provide a minimum of three hours' training.**

2. **Training Aid: Use the approved final version of maintenance manuals as a training aid.**

3. **Schedule training with Owner, through Architect [Engineer], with at least seven days' advance notice.]**

3.7 ON-SITE ASSISTANCE

A. Occupancy Adjustments: Within one year of date of Substantial Completion, provide up to three Project site visits, when requested, to adjust light levels, make program changes, and adjust sensors and controls to suit actual conditions.

B. Adjust time delay relays and clock timers to achieve specified system operation.

END OF SECTION 260923

SECTION 260924 - LOW VOLTAGE LIGHTING CONTROL

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 SCOPE

A. Applicable provisions of Division 1 shall apply to all work under this Section.

B. This section includes power supplies, control equipment and enclosures and switches.

1.3 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code.

1.4 SUBMITTALS

A. Submit product data under provisions of Division 1 and Division 26.

B. Submit field wiring diagrams, details, system integration diagrams and drawings.

1.5 RECORD DOCUMENTS

A. Submit record documents under provisions of Division 1 and Division 26.

B. Accurately record location of switches, power supplies, and control enclosures. Include description of switching and circuiting arrangements.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Division 1 and Division 26.

B. Include replacement part numbers.

PART 2 - PRODUCTS

2.1 COMPONENTS

A. Power Supply: ANSI/NFPA 70; Class 2 energy limited. 120/24 volt transformer, rated 75 VA momentary, 40 VA continuous, with silicon rectifier rated 20 amperes intermittent, 7.5 amperes continuous, 30 VAC.

B. Low Voltage Relays: Heavy duty, two-coil momentary contact type remote control relays with contacts rated 20 amperes at 120 volts and with isolated and non-isolated pilot

contacts where indicated. Include clamp type screw terminals for line voltage connections.

C. Switches: Momentary contact, three position switches, toggle type, ivory 1 color, rated 20 amperes at 120 VAC red with lighted handle.

D. Switch Plates: Per Division 26, Section, *Wiring Devices.*

E. Master Selector Switch: Capabilities with control of up to thirty-two relay outputs. Switch control shall be microprocessor based with two independent inputs and provide master group control, master switch leg extension and maintained to momentary input conversion.

F. Remote Control Interface: System shall be able to operate with remote input on an individual local switching basis.

G. Cabinets and Enclosures: Shop fabricated and wired in accordance with Division 26, Section, *Raceways and Boxes.* Include appropriate barrier strips for mounting relays and separating energy- limited wiring from line voltage wiring. Include knockouts for relay mounting. Include space for 10 percent minimum additional relays and one (1) additional power supply in each cabinet and enclosure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that surfaces are ready to receive work.

B. Verify field dimensions are as shown on Drawings.

C. Verify that required utilities are available, in proper location, and ready for use.

D. Beginning of installation means installer accepts existing conditions.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Use 20 AWG copper conductor building wire in conduit for low voltage wiring.

C. Install relays to be accessible. Allow space for adequate ventilation and circulation of air.

3.3 DEMONSTRATION AND TRAINING

A. Provide systems demonstration under the provisions of Division 16, Section, *General Electrical Requirements.* Provide a minimum of four (4) hours of demonstration and training.

B. Demonstrate proper operation of system.

END OF SECTION 260924

SECTION 260925 - PROGRAMMABLE LIGHTING CONTROL SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Scope: The extent of programmable lighting control system work is indicated on the drawings and schedules and by the requirements of this Section, and Division 26 Section, *Electrical Basic Requirements.*

B. Related Sections: Refer to other Division 26 sections for the following:

1. Raceway and Fittings.
2. Wire and Cables.
3. Control/Signal Wiring.
4. Boxes.
5. Wire Connections and Connecting Devices.
6. Electrical Identification.
7. Secondary Grounding.
8. Lighting.

1.3 QUALITY ASSURANCE

A. Codes and Standards: Provide a programmable lighting control system conforming to the following:

1. Comply with applicable sections of American National Standards Institute (ANSI), X4.14, *Alphanumeric Keyboard Arrangements Accommodating the Characteristic Sets of ASCII and ASCSOCR.*

2. Electronic Industries Association (EIA): Comply with applicable standards of EIA including the following:

   a. R5-453 Dimensional, Mechanical and Electrical Characteristics Defining Phone Jacks and Plugs.

b. R5-232 Interface Between Data Terminal Equipment and Data Communication Equipment Employing Binary Data Interchange.

3. Provide telephone equipment with Federal Communications Commission (FCC) labels indicating applicable FCC registration and numbering of equipment. Conform with applicable FCC regulations including the following:

a. Part 68

b. Part 15

c. Part 688, pertaining to telephone equipment registration by manufacturer.

4. Comply with National Electrical Manufacturers Association (NEMA) 250, *Enclosures for Electrical Equipment (1000 Volt Maximum).*

5. Comply with applicable sections of National Fire Protection Association (NFPA) 70, *National Electrical Code.*

6. Provide lighting control equipment and components that are Underwriters Laboratories, Inc. (UL) listed and labeled and comply with 916, *Energy Management Equipment.*

B. Standard Products: Conform to the requirements of Division 1, Section, *Products.*

1.4 SUBMITTALS

A. Division 1: Conform to the requirements of Division 1, Section, *Submittals.*

B. Product Data: Submit manufacturer's published data showing dimensions and characteristics of the system, physically and electrically, including:

1. Power input requirements including line voltage and power input, voltage and current rating of output contacts for On-Off control, and characteristics of battery back-up for clock memory retention.

2. Detailed description of master controller personal computer including keyboard, disk drives and type of disks; type and capacity of memory storage; type, size and vertical and horizontal resolution of display; and clock/calendar characteristics.

C. Shop Drawings: Submit for controls, drawings including the following:

1. Physical dimensions and weights of banks or racks of dimmers.

2. Electrical characteristics of dimmers including input current, power factor, neutral current and harmonic content at five equally spaced light output levels from minimum to maximum.

3. Control diagram showing all control wiring between controller and dimmers,

and between controller and photoelectric sensors. Specify wire or cable type and NEPA 70 wiring class.

D. Manufacturer's Instructions: Submit manufacturer's installation instructions as part of manufacturer's product data submittal.

E. Manuals: Provide operation and maintenance manuals including all aspects of the system submitted. Include instructions for maintenance and operation, including programming, changing programs, and manual override. Provide recommended spare parts list including current prices and sources.

PART 2 - PRODUCTS

2.1 PROGRAMMABLE LIGHTING CONTROL SYSTEM

A. General: Provide field programmable lighting control system providing programmed On-Off control of lighting, in areas designated on the drawings, and providing the following functions:

1. System real time clock, externally uninterruptible with battery backup of not less than 3 days, accuracy within I /2-second per day, resettable by the operator.

2. Scheduling capability of 7 days per week, 365 days per year with automatic leap year and daylight savings time adjustment and 32 holiday maximum.

3. Built-in error detection and diagnostic aids.

4. Non-volatile memory (not affected by loss of power) and automatic reboot to bring program back on-line upon restoration of power.

5. Manual override at the operator's console or at the controlled lighting circuits, without change to programmed schedules.

6. Four levels of access codes to prevent tampering by unauthorized personnel.

7. Disc program storage with a maximum access time of 60-milliseconds and not less than 10-megabytes of formatted storage or not less than the storage necessary to support the requirements specified plus 100 percent expansion of the disk resident data base, with no disk filled to more than 50 percent of its formatted capacity at completion of testing.

8. Standard printer connection for plug-in of a future hard-copy data printer.

9. All hardware and terminals to connect to a complete and operational system.

C. Contactors: Provide electrically operated, mechanically held contactors with number of poles and ratings indicated on the drawings and schedules. Arrange to provide On-Off control of circuits indicated on the drawings and schedules with control from programmed schedule of the controller.

D. Relays: Provide electrically operated, mechanically held, 30-ampere, 600 VAC relays including the following features:

1. Coil voltage and current to suit controller load contacts.

2. Silver alloy contacts suitable for tungsten and ballast lighting, and general mixed loads with interrupting capacity of 90-ampere at 480 volt.

3. Number of poles as required to suit the switched circuits.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install programmable lighting control system in accordance with the NEC and the manufacturer's written instructions. Provide all required interconnections using the wiring methods required by Division 26 Section, *Raceways,* Division 26 Section, *Wire and Cables* and Division 26 Section, *Control/Signal Wiring,* for the NFPA 70 classes of the power and signal circuits.

1. Provide steel channel or angle mounting racks as recommended by the manufacturer and as shown on the drawings.

B. Programming: Program the system completely to provide the functions specified by the Owner’s Representative. Provide original and two copies of all software.

C. Cleaning and Touch-Up: Clean all dirt and debris from inside and outside of all system components after mounting and wiring and before placing into operation. Touch-up scratched or marred surfaces to match original finish.

D. Occupancy Adjustments: When requested within one year of date of substantial completion, provide up to three on-site visits to assist in adjusting light levels, program changes, and adjusting dimmer controls to suit occupant requirements.

3.2 FIELD QUALITY CONTROL

A. Field Tests, Adjustments, and Demonstrations: Provide the services of a factory trained and authorized service representative to assist with field tests, adjustments, and demonstrations. Perform field tests and demonstrate functioning of all features including:

1. Check power and signal wiring for continuity, short circuits and insulation resistance. Ensure that enclosures, equipment, and raceways are properly grounded.

2. Energize the system, program the controller, and check each controlled area, using a calibrated light meter, for the programmed light level adjusting components as required. Demonstrate the system to prove capability and compliance with requirements. Correct malfunctions at site and retest to prove compliance. If required, remove and replace components and retest.

B. Instruction: Provide the services of a competent instructor for a period of one day to train the occupant's personnel in the programming, operation and maintenance of the system.

END OF SECTION 260925

SECTION 260926 - OCCUPANCY SENSORS

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.

B. Division 26 Section, "Low Voltage Lighting Control System".

C. Division 26 Section, "Addressable Lighting Control System".

1.2 WORK INCLUDED

A. Work to include all labor materials, tools, appliances, control hardware, sensor, wire, junction boxes and equipment necessary for and incidental to the delivery, installation and furnishing of a completely operational occupancy sensor lighting control system, as described herein.

B. Examine all general specification provisions and drawings for related electrical work required as work under Division 26.

C. Coordinate all work described in this section with all other applicable plans and specifications, including but not limited to wiring, conduit and fixtures.

1.3 EQUIPMENT QUALIFICATION

A. Products supplied shall be from a manufacturer that has been continuously involved in the manufacturing of occupancy sensors for a minimum of five (5) years.

B. All components shall be UL listed, offer a five (5) year warranty and meet all state and local applicable code requirements.

1.4 SYSTEM DESCRIPTION

A. The objective of this section is to ensure the proper installation of the occupancy sensor based lighting control system so that lighting is turned off automatically after 10 minutes of time delay when a room or area is vacated by the last person to occupy said room or area.

B. The occupancy sensor based lighting control shall accommodate all conditions of space utilization and all irregular work hours and habits.

C. Warrant all equipment furnished in accordance to this specification to be undamaged, free of defects in materials and workmanship, and in conformance with the specifications. The suppliers' obligation shall include repair or replacement and testing, without charge to the Owner, all or any parts of equipment which are found to be damaged, defective or non-conforming and returned to the supplier. The warranty shall commence upon the Owner's acceptance of the project. Warranty on labor shall be for a minimum period of two (2) years.

1.5 SUBMITTALS

A. Manufacturer shall substantiate conformance to this specification by supplying the necessary documents, performance data and wiring diagrams. Any deviations to this specification must be clearly stated by letter and submitted.

B. Submit a lighting plan clearly marked by manufacturer showing proper product, location and orientation of each sensor. Submit Shop Drawings indicating wiring diagrams, showing interface with branch circuit wiring.

C. Submit any interconnection diagrams per major subsystem showing proper wiring.

D. Submit standard catalog literature which includes performance specifications indicating compliance to the specification. Provide product data showing dimensions and ratings of components.

1.6 SYSTEM OPERATION

A. Responsibility to make all proper adjustments to assure Owner's satisfaction with the occupancy system.

1.7 ACCEPTABLE MANUFACTURERS

A. Watt Stopper, Sensor Switch, or approved equal.

B. The listing of any manufacturer as *acceptable* does not imply automatic approval. Ensure that any price quotations received and submittals made are for sensors which meet or exceed the specifications included herein.

PART 2 - PRODUCTS

2.1 GENERAL

A. Product numbers for Watt Stopper are as follows:

1. Ceiling-mounted Sensors:

a. Corridors: WT-2255 (white)

b. Other Spaces: DT-300 (white)

2. Wall and corner-mounted Sensors: DT-200 (white) with wire guards as indicated on drawings.

3. Wall Switch Sensors:

a. Single Relay: DW- 100 (ivory).

b. Dual Relay: DW-200 (ivory).

4. Power Pack Modules: BZ- 150 (dual voltage).

B. Wall switch sensors shall be capable of detection of motion at desk-top level up to 300

square feet, and gross motion up to 1,000 square feet.

C. Wall switch sensors shall accommodate loads from 0 to 800 watts at 120 volts; 0 to 1200 watts at 277 volts and shall have 180-degree coverage capability.

D. Sensors shall be dual-technology type using a combination of passive-infrared and ultrasonic detection method to distinguish between occupied and unoccupied conditions for area covered.

E. Sensors shall feature built-in light level sensing for field-adjustable ambient light override.

F. All sensors shall be capable of operating normally with any electronic ballast and PL lamp systems.

G. Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to the cycling of air conditioner or heating fans.

H. All sensors shall have readily accessible, user adjustable controls for time delay and sensitivity. Controls shall be recessed to limit tampering.

I. In the event of failure, a bypass manual *override on* shall be provided on each sensor. When bypass is utilized, lighting shall remain on constantly or control shall divert to a wall switch until sensor is replaced. This control shall be recessed to prevent tampering.

J. Ultrasonic operating frequency shall be crystal controlled to within plus or minus 0.005 percent tolerance to assure reliable performance and eliminate sensor cross-talk. Sensors using multiple frequencies are not acceptable.

K. All sensors shall provide a method of indication to verify that motion is being detected during testing and that the unit is working.

L. All sensors shall have no leakage current to load, in manual or in Auto/Off Mode, for safety purposes and shall have voltage drop protection.

M. All sensors shall have UL rated, 94V-0 plastic enclosures.

2.2 CIRCUIT CONTROL HARDWARE:

A. Power Pack Modules - for ease of mounting, installation and future service, Power Pack(s) shall be able to externally mount through a 1/4-inch knock-out on a standard electrical enclosure and be an integrated, self-contained unit consisting internally of an isolated load switching control relay and a transformer to provide low-voltage power. Transformer shall provide power to a minimum of three (3) sensors. Power Packs shall be UL listed.

B. Relay Contacts shall have ratings of:

20A - 120 VAC Tungsten 20A -
120 or 277 VAC Ballast

2.3 CONTROL WIRING BETWEEN SENSORS AND CONTROLS

A. Control wiring between sensors and controls shall be Class II, 18-24 AWG, stranded UL Classified, PVC-insulated or Teflon-jacketed cable approved for use in plenums, where applicable.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Locate and aim sensors in the correct location required for complete and proper volumetric coverage within the range of coverage(s) of controlled areas per the manufacturer's recommendations. Rooms shall have ninety (90) to one hundred (100) percent coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the room(s). The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms which are to be provided with sensors. Provide additional sensors if required to properly and completely cover the respective room.

B. The following areas shall have one hundred (100%) percent coverage for small-motion:

1. Exam Rooms
2. Desks in office areas
3. Restrooms

C. Arrange a pre-installation meeting with the manufacturer's factory authorized representative, at the Owner's facility, to verify placement of sensors and installation criteria.

D. Proper judgment must be exercised in executing the installation so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components. Provide, at the Owner's facility, the training necessary to familiarize the Owner's personnel with the operation, use, adjustment, and problem-solving diagnosis of the occupancy-sensing devices and systems.

1. Sensors shall be mounted where they will not receive light directly from a light source or reflecting source.

2. Sensor shall be mounted at least 4 feet from HVAC vents to avoid air current interference.

3. Sensors installed in damp locations such as near showers, in wet locations, or where exposed to rain shall be equipped with watertight/weatherproof enclosure.

4. Mounting of passive infrared and dual technology sensors where columns, doors, walls, or other obstructions will block the sensor's field of view should be avoided.

E. Passive infrared coverage should not extend through doorways. Masking inserts shall be installed for PIR coverage rejection to prevent false tripping.

F. Install system components in accordance with Manufacturer's instructions. Sensor locations are approximate and are designed according to the specified manufacturer.

G. Sensors shall be positioned so that lights are activated when a person is 2 feet or less through any doorway.

H. Prior to energizing circuits, wiring shall be tested for electrical continuity and short circuits to ensure proper polarity of connections is maintained.

3.2 CONTROL WIRING INSTALLATION

A. Install wiring between sensing and control devices according to manufacturer's written instructions and as specified in Division 26 Section *Conductors and Cables* for low-voltage connections for digital circuits.

B. Wiring Method: Install all wiring in raceway as specified in Division 26 Section *Raceways and Boxes,* unless run in accessible ceiling space and gypsum board partitions.

C. Bundle, train, and support wiring in enclosures.

D. Ground equipment.

E. Connections: Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

F. Connect control devices to systems controlled, to achieve proper system operation.

3.3 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Electrical Identification".

3.4 FIELD QUALITY CONTROL

A. Schedule visual and mechanical inspections and electrical tests with at least seven days' advance notice.

B. Inspect control components for defects and physical damage, testing laboratory labeling, and nameplate compliance with the Contract Documents.

C. Check tightness of electrical connections with torque wrench calibrated within previous six months. Use manufacturer's recommended torque values.

D. Verify settings of photoelectric devices with photometer calibrated within previous six months.

E. Electrical Tests: Use particular caution when testing devices containing solid-state components. Perform the following according to manufacturer's written instructions:

1. Continuity tests of circuits.

2. Operational Tests: Set and operate devices to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions. Include testing of devices under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional

observations.

F. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.

G. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.

H. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

3.5 CLEANING

A. Cleaning: Clean equipment and devices internally and externally using methods and materials recommended by manufacturers, and repair damaged finishes.

3.6 FACTORY COMMISSIONING:

A. Upon completion of the installation, the system shall be completely tested by the manufacturer's factory-authorized technician who will verify all adjustments and sensor placement to ensure a trouble-free occupancy-based lighting control system. This service is to be provided at no additional cost.

B. Provide both the manufacturer and the Engineer with ten working days written notice of the scheduled testing date. Upon completion of the system fine tuning, the factory-authorized technician shall provide the proper training to the Owner's personnel in the adjustment and maintenance of the sensors.

END OF SECTION 260926

SECTION 260927 - LIGHTING CONTROL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. The work covered in this section is subject to all of the requirements in the General Conditions of the Specifications. Contractor shall coordinate all of the work in this section with all of the trades covered in other sections of the specification to provide a complete and operable system. All labor, materials, appliances, tools, equipment, facilities, transportation and services necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the work of this Section.

1.2 DESCRIPTION OF WORK

A. Furnish and install a complete system for the control of lighting and other equipment as indicated on the plans, detailed in the manufacturer submittal and as further defined herein. Contractor is solely responsible to verify quantity, installation locations and wiring requirements for this project. Specific manufacturers' catalog numbers, when listed in this section are for reference only. It is the responsibility of the contractor to verify with lighting control manufacturer all catalog information and specific product acceptability.

B. The system shall include but not be limited by the following list: Pre-wired, microprocessor controlled relay panels with electrically held, electronically latched relays panels controlled via a complete list of communication based accessories including digital switches, digital photocells, Digital Time Clock (DTC) and interface cards to building automation systems and other devices. The type of lighting control equipment and wiring specified in this section is covered by the description: Microprocessor Controlled Digital Relay Lighting Control system with RS 485 Bus communications. Requirements are indicated elsewhere in these specifications for work including, but not limited to. raceways and electrical boxes and fittings required for installation of control equipment and wiring. They are not the work of this section.

1.3 SUBMITTALS

A. Refer to Section 260501 — *General Electrical Requirements,* Paragraph - *Shop Drawing Requirements.*

B. Shop Drawings: Submit dimensioned drawings of lighting control system and accessories including, but not necessarily limited to, relay panels, switches, DTC, photocells and other interfaces. Shop drawings shall indicate exact location of each device or a RFI to confirm location. Plans are diagrammatical. EC to verify all lighting control material requirements from approved shop drawings. "Cut Sheet" submittal not acceptable.

C. Product Data: Submit for approval 6 copies of manufacturer's data on the specific lighting control system and components. Submittal shall be in both electronic and hard copy formats. To prevent departures from approved system operation, electronic file submitted shall be able to be directly downloaded to the specified system at manufacturer facility. Submit a complete bill of materials with part numbers, description and voltage

specifications.

D. One Line Diagram: Submit a one-line diagram of the system configuration indicating the type, size and number of conductors between each component if it differs from that illustrated in the riser diagram in these specifications. Submittals that show typical riser diagrams are not acceptable.

1.4 QUALITY ASSURANCE

A. Products shall be manufactured by Lighting Control & Design or approved equal by Watt Stopper, Douglas. Hubbell or NexLight. Such firms shall be regularly engaged in manufacture of lighting control equipment and ancillary equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years. Any product other than those listed in this specification must be pre-approved a minimum of two weeks before bid time. No exceptions.

B. Control wiring shall be in accordance with the NEC requirements for Class 2 remote control systems, Article 725 and manufacturer specification.

C. A licensed electrician shall functionally test each system component after installation, verify proper operation and confirm that all relay panel and switch wiring conforms to the wiring documentation. The Electrical Contractor (EC) is required to phone LC&D a minimum of 7 days before turnover for system checkout. At time of LC&D contact, all components to include phone line to modem must be installed, powered and operational.

D. Comply with NEC and all local and state codes as applicable to electrical wiring work.

E. Lighting control panels shall be UL 916 Listed. LCPs controlling emergency circuits shall be ETL listed to UL 924. Emergency source circuits controlled in normal operation by a relay panel shall fully comply with NEC 700-9(b). Electrical Contractor is responsible for verifying compliance.

F. The lighting control system shall be listed, approved and comply as required with all national, state and local energy codes to include but not limited to California Title 24 and ASHRAE 90.1-2004.

1.5 MAINTENANCE MATERIALS

A. Division 01 - *Execution Requirements:* Spare parts and maintenance products.

B. Provide 10% spare relays per LCP, up to the maximum capacity of the LCP.

C. Provide CD version of manufacturers operating software to include graphical interface software.

D. Provide 2 extra sets of as-built and operating manuals.

1.6 SUBSTITUTIONS

A. Substitutions are permitted as voluntary alternates. Base bid must reflect the specified equipment.

B. A product must go through the following process before being approved as a substitution:

1. A list of substitutions shall be provided to the owner as an attachment to the bid form. Submit along with bill of material, CD of proposed operating system, and a one line diagram of the system configuration proposed indicating the type, size and number of conductors between each component.

1.7 SYSTEM DESCRIPTION

A. The lighting control system is a networked system that communicates via RS485. The system must be able to communicate with fully digital centralized relay panels, micro relay panels, smart breaker panels, digital switches, photocells, various interfaces and shall include all operational software. The intent of the specification is to integrate all lighting control into one system, except for areas controlled by a single motion sensor such as rooms with a single luminaire and emergency fixtures designed to operate 24/7. Distributed lighting control shall be provided using a networked micro relay panel. A centralized relay panel shall control corridors and site lighting. Lighting control system shall include all hardware and software. Software to be resident within the lighting control system. System shall provide local access to all programming functions at the master LCP and remote access to all programming functions via dial up modem and through any standard computer workstation running an industry standard internet browser. Lighting control system shall have server built into the master LCP that "serves" HTML pages to any authorized workstation. Desktop computers are not part of this section and will be provided by others. Non-networked, non-digital, non-server capable systems not acceptable.

B. System software shall provide real time status of each relay, each zone and each group.

C. Lighting control system shall be able to be monitored by and take commands from a remote PC. At any time, should the remote PC go off-line all system programming uploaded to the lighting control system shall continue to operate as intended. Systems requiring an online PC or server for normal operation are not acceptable

D. All devices shall be pre-addressed at the factory. Field addressing is not acceptable.

E. All programs, schedules, time of day, etc. shall be held in non-volatile memory for a minimum of 10 years at power failure. At restoration of power, lighting control system shall implement programs required by current time and date.

F. System shall be capable of flashing lights Off/On for any relay or any zone prior to the lights being turned Off. The warning interval time between the flash and the final lights off signal shall be definable for each zone. Occupant shall be able to override any scheduled Off sweep using local wall switches within the occupied space. Occupant override time shall be locally and remotely programmable and not exceed 2-hours.

G. The system shall be capable of implementing On commands, Off commands, Raise (dimming) commands, Lower (dimming) commands for any relay, group or zone by means of digital wall switches, specification grade line voltage type wall switches, photocell web based software or other devices connected to programmable inputs in a lighting control panel.

H. The lighting control system shall provide the ability to control each relay and each relay group per this specifications requirement. All programming and scheduling shall be able to be done locally at the master LCP and remotely via dial up modem and via the Internet. Remote connection to the lighting control system shall provide real time control

and real time feedback.

I. System may consist of centralized relay panels, micro relay panels, smart breaker panels, digital switches, photocells and various digital interfaces. Verify exact components specified. Micro relay panels, smart breaker panels, centralized relay panels and digital switches shall communicate as one network via RS485. Micro relay panels, mounted in each local area, per plans shall control all lighting fixtures in that space, provide power to occupancy sensors and take input from daylight sensor and occupancy sensors. Micro relay panels shall be capable of taking inputs from standard, line voltage type switches and outputting up to 8 independent Ov to 10v dimming signals. All micro relay panels and all devices connected to micro relay panels (switches, photocells and occupancy sensors, etc.) shall be wired per lighting control manufacturer's instructions.

PART 2 - PRODUCTS

2.1 MATERIAL AND COMPONENTS

A. Relay Panels:

1. NEMA rated enclosure with screw cover or hinged door. Other NEMA types optional.

2. 16 AWG steel barrier shall separate the high voltage and low voltage compartments of the panel and separate 120v and 277v.

3. LCP input power shall be capable of accepting 120v or 277v without rewiring

4. Control electronics in the low voltage section shall be capable of driving 2 to 48. 30a, 18.000 SCCR rated latching relays, control any individual or group of relays, provide individual relay overrides, provide a master override for each panel, store all programming in non-volatile memory, after power is restored return system to current state, provide programmable blink warn timers for each relay and every zone, and be able to control relays that default to Open, Normally Open Latching (NOL) or relays that default to Closed, Normally Closed Latching (NCL).

5. Lighting control system shall be digital and consist of a Master LCP with digital interface cards. All system components shall connect and be controlled via a single Category 5, 4 twisted pair cable with RJ45 connectors, providing real time two-way communication with each system component. Analog systems are not acceptable.

6. The lighting control system is a networked system that communicates via RS485 and includes a centralized relay panel a photocell, various interfaces and operational software. The intent of the specification is to integrate all lighting control into one system. Lighting control system shall include all hardware and software. Software to be resident within the lighting control system. System shall provide local access to all programming functions at the DTC and remote access to all programming functions via dial up modem and through any standard computer workstation running an industry standard internet browser. Lighting control system shall have server built into the master LCP that "serves" HTML pages to any authorized workstation. Desktop computers are not part of this section and will be provided by others. Non-networked, non-digital system not acceptable.

B. Micro Relay Panels

1. Micro relay panels shall have up to 8-30a, 18.000 SCCR rated lighting relays and shall control all lighting in the designated area indicated on the plans and be networked to centralized relay panels, micro relay panels, smart breaker panels, digital switches, photocells, various interfaces. Each micro relay panel shall provide minimum 300ma at 12/24vdc for powering occupancy sensors. Micro relay panels that require a separate occupancy sensor power pack are not acceptable.

2. Micro relay panel shall provide a minimum 4 programmable photocell inputs, a minimum 4 programmable occupancy sensor inputs and matrixed contact closure inputs. This requirement is to insure integration of entire lighting system into one networked, lighting control system.

3. Micro relay panels shall be capable of outputting minimum 4 and up to 8 independent Ov to 10v dimming signals, one independent dimming signal at each of 8 relays. In order to maximize daylight harvesting and minimize disruption to occupants, each dimming output shall provide adjustment for baseline, start point, mid-point, end point, trim, fade down rate, time delay and enable/disable masking. All photocell setting must be remotely accessible. Systems providing On, Off with Time Delay only and system that do not provide remote access are not acceptable.

C. Standard Output relays

1. UL Listed 30 Amp, Latching. 18,000 SCCR, 277VAC Ballast and HID and 20 Amp Tungsten at 120 Vac.

2. Relays shall be individually replaceable. Relay terminal blocks shall be capable of accepting two (2) #8AWG wires on both the line and the load side. Systems that do not allow for individual relay replacement or additions are not acceptable.

3. Relays to be rated for 250,000 operations minimum at a full 30a lighting load, default to closed at normal power loss. Normally Closed Latching (NCL). All incandescent circuits shall be energized by use of a Normally Closed SoftStartTM (NCSS) relay rated at 100.000 operations at full 20a load. No exceptions.

4. Optional relay types available shall include: Normally Open Latching (NOL) relay rated for 250.000 operations, a 600v 2-pole NO and NC and a Single Pole, Double Throw (SPDT) relay.

D. DTC - Digital Electronic Time Clock

1. A Digital Time Clock (DTC) shall control and program the entire lighting control system and supply all time functions and accept interface inputs.

2. DTC shall be capable of up to 32 schedules. Each schedule shall consist of one set of On and Off times per day for each day of the week and for each of two holiday lists. The schedules shall apply to any individual relay or group of relays.

3. The DTC shall be capable of controlling up to 126 digital devices on a single bus and capable of interfacing digitally with other individual busses using manufacturer supplied interface cards.

4. The DTC shall accept control locally using built in button prompts and use of an 8 line 21-letter display or from a computer or modem via an on-board RS 232 port.

   All commands shall be in plain English. Help pages shall display on the DTC screen.

5. The DTC shall be run from non-volatile memory so that all system programming and real time clock functions are maintained for a minimum of 15 years with loss of power.

6. Pre-installed Unityrm lighting control software shall provide via local or remote PC a visual representation of each device on the bus, show real time status and the ability to change the status of any individual device, relay or zone. System shall be capable of running optional Unity GX lighting control software, which shall provide for directly importing vector based graphics. No exceptions.

7. Pre-Installed modem that allows for remote programming from any location using a PC. Modem to include all necessary software for local or remote control.

8. DTC shall provide system wide timed overrides. Any relay, group or zone that is overridden On, before or after hours, shall automatically be swept Off by the DTC a maximum of 2 hours later.

E. Photocell: Photocells to be mounted in location indicated on the plans. Photocells used for exterior lights shall provide multiple trips point from 1 roof mounted unit. All trips points shall be able to be changed remotely via Internet or dial up modem. Photocells requiring manual trip point adjustment are not acceptable.

F. Interfaces: For future expansion capability, system to have available all of the following interfaces.

1. Direct digital interface to building automation systems using DDC protocols such as BACnet, Metasys (N2) and ModBus that accept on/off commands, time schedules and report status of all relays in all panels in real time. Interface cards shall "self-populate" each individual relay and each group to the BAS. All BAS system programming required shall be the responsibility of the BAS system provider.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Mount relay control cabinets adjacent to respective lighting panelboard. Cabinet shall be surface or flush mount, per plans. Wiring between relay control cabinet and panelboards to be per local codes and acceptable industry standards. Under no circumstances will any extra be authorized for payment to the EC or GC due to the EC's lack of knowledge or understanding of any and all prevailing codes or specified manufacturer's installation requirements. Neatly lace and rack wiring in cabinets. During construction process, protect all interior components of each relay panel and each digital switch from dust and debris. Any damage done to electronic components due to non-protection shall be the sole responsibility of the installing contractor.

B. Wiring

1. Do not mix low voltage and high voltage conductors in the same conduit. No exceptions.

2. Ensure low voltage conduits or control wires do not run parallel to current carrying conduits.

3. Place manufacturer supplied "terminators" at each end of the system bus per manufacturer’s instructions.

4. Neatly lace and rack wiring in cabinets.

5. Plug in Category 5 patch cable that has been field-tested with a recognized cable tester, at the indicated RJ45 connector provided at each lighting control device, per manufacturer’s instructions.

6. Use Category 5 patch cable for all system low voltage connections. Additional conductors may be required to compensate for voltage drop with specific system designs. Contact LC&D or refer to the GR2400 manual for further information. Use shielded cable for dry contact inputs to lighting control system.

7. Do not exceed 4000ft-wire length for the system bus.

8. All items on the bus shall be connected in sequence (daisy chained). Star and spur topologies are not acceptable.

9. The specified lighting control system shall be installed by the electrical contractor who shall make all necessary wiring connections to external devices and equipment, to include photocell. Electrical Contractor is to wire per manufacturer's instructions.

3.2 INSTALLATION AND SET-UP

A. Verify that conduit for line voltage wires enters panel in line voltage areas and conduit for low-voltage control wires enters panel on low-voltage areas. Refer to manufacturer's plans and approved shop drawings for location of line and low-voltage areas. It is the responsibility of the contractor to verify with lighting control manufacturer all catalog information and specific product acceptability.

B. Contractor to test all low voltage cable for integrity and proper operation prior to turn over. Verify with system manufacturer all wiring and testing requirements.

C. Before Substantial Completion, arrange and provide a one-day Owner instruction period to designated Owner personnel. Set-up, commissioning of the lighting control system and Owner instruction includes:

1. Confirmation of entire system operation and communication to each device.

2. Confirmation of operation of individual relays, switches, occupancy sensors and daylight sensors

3. Confirmation of system Programming, photocell settings, override settings, etc.

4. Provide training to cover installation, maintenance, troubleshooting, programming, and repair and operation of the lighting control system.

D. Panels shall be located so that they are readily accessible and not exposed to physical damage.

E. Panel locations shall be furnished with sufficient working space around panels to comply with the National Electrical Code.

F. Panels shall be securely fastened to the mounting surface by at least 4 points.

G. Unused openings in the cabinet shall be effectively closed,

H. Cabinets shall be grounded as specified in the National Electrical Code.

I. Lugs shall be suitable and listed for installation with the conductor being connected.

J. Conductor lengths shall be maintained to a minimum within the wiring gutter space. Conductors shall be long enough to reach the terminal location in a manner that avoids strain on the connecting lugs.

K. Maintain the required bending radius of conductors inside cabinets.

L. Clean cabinets of foreign material such as cement, plaster and paint.

M. Distribute and arrange conductors neatly in the wiring gutters.

N. Follow the manufacturer's torque values to tighten lugs.

O. Before energizing the panelboard, the following steps shall be taken:

1. Retighten connections to the manufacturer's torque specifications. Verify that required connections have been furnished.

2. Remove shipping blocks from component devices and the panel interior.

3. Remove debris from panelboard interior.

P. Follow manufacturers' instructions for installation and all low voltage wiring.

Q. Service and Operation Manuals:

1. Submit operation and service manuals. Complete manuals shall be bound in flexible binders and data shall be typewritten or drafted.

2. Manuals shall include instructions necessary for proper operation and servicing of system and shall include complete wiring circuit diagrams of system, wiring destination schedules for circuits and replacement part numbers. Manuals shall include as-built cable Project site plot plans and floor plans indicating cables, both underground and in each building with conduit, and as-built coding used on cables. Programming forms of systems shall be submitted with complete information.

R. Comply with energy code lighting control system "Acceptance Requirements". Acceptance tests are used to verify that lighting controls were installed and calibrated correctly. These tests may require that a responsible party certify that controls are installed and calibrated properly. This is the installing contractors' responsibility. Verify requirements with building authority.

3.3 DOCUMENTATION

A. Each relay shall have an identification label indicating the originating branch circuit number and panelboard name as indicated on the drawings. Each line side branch circuit conductor shall have an identification tag indicating the branch circuit number.

B. Provide a point-to-point wiring diagram for the entire lighting control system. Diagram must indicate exact mounting location of each system device. This accurate "as built" shall indicate the loads controlled by each relay and the identification number for that relay, placement of switches and location of photocell. Original to be given to owner, copies placed inside the door of each LCP.

3.4 SERVICE AND SUPPORT

A. Start Up: EC shall contact LC&D at least 7 days before turnover of project. LC&D will remotely dial into the lighting control system, run diagnostics and confirm system programming. EC shall be available at the time of dial in to perform any corrections required by LC&D. EC is responsible for coordinating with GC and the owner the installation of a dedicated telephone line or a shared phone line with AB switch. Phone jack to be mounted within 12" of Master LCP. Label jack with phone number. EC to connect phone line from jack to Master LCP.

B. Telephone factory support shall be available at no additional cost to the EC or Owner both during and after the warranty period. Factory to pre-program the lighting control system per plans and approved submittal, to the extent data is available. The specified manufacturer, at no added cost, shall provide additional remote programming via modem as required by the EC or Owner for the operation life of the system. Upon request manufacturer to provide remote dial up software at no added cost to system owner. No exceptions.

C. Provide a factory technician for on-site training of the owners' representatives and maintenance personnel. Coordinate timing with General Contractor. Provide factory on-site training as required.

3.5 CLEANING

A. Division 1 - Execution Requirements: Final cleaning.

B. Clean photocell lens as recommended by manufacturer.

C. Clean all switch faceplates.

END OF SECTION 260927

SECTION 261200 - MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Liquid-filled pad-mounted distribution transformers.

1.02 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete: Pads for transformer support.

1.03 REFERENCE STANDARDS

A. IEEE C37.47 - American National Standard Specifications for Distribution Fuse Disconnecting Switches, Fuse Supports, and Current-Limiting Fuses; 2000. (ANSI/IEEE C37.47)

B. IEEE C57.12.28 - IEEE Standard for Pad-Mounted Equipment -- Enclosure Integrity; 2005.

C. IEEE C57.12.00 - IEEE Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers; Institute of Electrical and Electronic Engineers; 2006.

D. IEEE C57.12.01 - IEEE Standard General Requirements for Dry-Type Distribution and Power Transformers Including Those With Solid Cast and/or Resin-Encapsulated Windings; Institute of Electrical and Electronic Engineers; 2005.

E. IEEE C57.12.90 - IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers; Institute of Electrical and Electronic Engineers; 2006.

F. IEEE C57.111 - IEEE Guide for Acceptance of Silicone Insulating Fluid and Its Maintenance in Transformers; Institute of Electrical and Electronic Engineers; 1989 (R2003).

G. IEEE C57.121 - IEEE Guide for Acceptance and Maintenance of Less Flammable Hydrocarbon Fluid in Transformers; Institute of Electrical and Electronic Engineers; 1998.

H. IEEE 386 - IEEE Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600 V; Institute of Electrical and Electronic Engineers; 2006.

I. NEMA 260 - Safety Labels for Padmounted Switchgear and Transformers Sited in Public Areas;
National Electrical Manufacturers Association; 1996 (2004).

J. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2009.

K. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 SUBMITTALS

A. Shop Drawings: Indicate electrical characteristics and connection requirements, outline

dimensions, connection and support points, weight, specified ratings and materials.

B. Product Data: Provide electrical characteristics and connection requirements, standard model design tests, and options.

C. Test Reports: Indicate procedures and results for specified factory and field testing and inspection.

D. Manufacturer's Installation Instructions.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

F. Manufacturer's Field Reports: Indicate activities on site, adverse findings, and recommendations.

G. Project Record Documents: Include copy of manufacturer's certified drawings.

H. Maintenance Data: Include maintenance instructions for cleaning methods; cleaning materials recommended; procedures for sampling and maintaining fluid.

I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section transformer schedule on drawing E-3 - Product Requirements, for additional provisions.
   2. Tools: One each of every special tool required to operate and maintain transformer.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles (160 km) of Project.

C. Testing Agency Qualifications: Company member of International Electrical Testing Association and specializing in testing products specified in this section with minimum three years documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect transformers from moisture by using appropriate heaters as instructed by the manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Cooper Power Systems, a division of Cooper Industries: www.cooperindustries.com.

B. Eaton Corporation; Cutler-Hammer Products: www.eaton.com.

C. Schneider Electric; Square D Products; Model CLASS 7230 or equal to www.schneider-electric.us.

D. Substitutions: See Section 01 6000 - Product Requirements.

2.02 LIQUID-FILLED TRANSFORMERS

A. Liquid-Filled Transformers: IEEE C57.12.00, three phase, pad-mounted, self-cooled transformer unit.

B. Cooling and Temperature Rise; IEEE C57.12.00; Class OA. 65 degrees C, self-cooled.

C. Insulating Liquid: seed oil base fluid.

2.03 SERVICE CONDITIONS

A. Meet requirements for usual service conditions described in IEEE C57.12.01 and for the specified unusual service conditions.

2.04 RATINGS

A. Capacity: 500 kVA.

B. Primary Voltage: 15 kV delta connected.

C. Taps: Standard primary taps.

D. Secondary Voltage: 480/277 volts, wye connected.

E. Impedance: 1.5/5.00% percent maximum.

F. Basic Impulse Level: 95 KV.

2.05 ACCESSORIES

A. Accessories: IEEE 057.12.00 standard accessories.

B. Primary Terminations: Bushing wells to IEEE 386; provide three for radial feed. Include bushings for insulated loadbreak connectors.

C. Secondary Terminations: Spade lugs.

2.06 FABRICATION

A. Conform to the requirements of IEEE C57.12.28.

2.07 FACTORY FINISHING

A. Clean surfaces before applying paint.

B. Apply corrosion-resisting primer to all surfaces.

C. Apply finish coat of baked enamel paint to 2 mils (0.5 mm) thick.

D. Finish Color: Manufacture's standard.

2.08 SOURCE QUALITY CONTROL

A. Provide factory tests to IEEE 057.12.90 and IEEE 057.12.00. Include the routine tests as defined in the standards and the following other tests:
   1. Impedance voltage and load loss.
   2. Dielectric tests.
   3. Audible sound level.
   4. Short circuit capability.
   5. Zero-phase-sequence impedance voltage.
   6. Temperature rise.

B. Test insulating liquid samples in accordance with IEEE 057.111.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that support pads provided by the electrical contractor are ready to receive products.

B. Verify that field measurements are as indicated on shop drawings.

3.02 INSTALLATION

A. Install plumb and level.

B. Install safety labels to NEMA 260.

3.03 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 01 4000.

B. Inspect and test in accordance with NETA STD ATS, except Section 4.

C. Perform inspections and tests listed in NETA STD ATS, Section 7.2. In addition to the basic requirements of Section 7.2, include the following:
1. Liquid-Filled Transformers

3.04 ADJUSTING

A. Adjust primary taps so that secondary voltage is within 2 percent of rated voltage.

END OF SECTION 261200

SECTION 261216 - TRANSFORMERS

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 dry-type distribution, non-linear load transformers rated 1000 V and less.

1.3 SUBMITTALS

A. Product Data: Include data on features, components, ratings, dimensions, weight, and performance for each type of transformer specified. Include dimensioned plans, sections, and elevation views. Show minimum clearances and installed devices and features.

B. Wiring Diagrams: Detail wiring and identify terminals for tap changing and connecting field-installed wiring.

C. Product Certificates: Signed by manufacturers of transformers certifying that the products furnished comply with requirements.

D. Qualification Data: For firms and persons specified in *Quality Assurance* Article.

E. Field Test Reports: Indicate and interpret test results for tests specified in Part 3.

F. Maintenance Data: For transformers to be included in the maintenance manuals specified in Division 1.

G. Project Record Documents: Record actual transformer locations.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: In addition to requirements specified in Division 1 Section *Quality Control*, an independent testing agency shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907; or shall be a full-member company of the International Electrical Testing Association.

1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies, to supervise on-site testing specified in Part 3.

B. Listing and Labeling: Provide transformers specified in this Section that are listed and labeled.

1. The Terms *Listed* and *Labeled:* As defined in NFPA 70, Article 100.

2. Listing and Labeling Agency Qualifications: A *Nationally Recognized Testing Laboratory* as defined in OSHA Regulation 1910.7.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit throughout periods during which equipment is not energized and is not in a space that is continuously under normal control of temperature and humidity.

B. Store and protect equipment in a dry location with uniform temperature. Cover ventilation openings to keep dust out.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, supply equipment from one of the following manufacturers: No other manufacturers are acceptable.

1. Square D Company

2. Eaton/Cutler-Hammer

3. Acme Electric Corp.; Transformer Division.

2.2 TRANSFORMERS, GENERAL

A. Description: Factory-assembled and tested, air-cooled units of types specified, designed for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous copper windings without splices, except for taps.

D. Coil Conductors: Individual insulate secondary conductors and arrange to minimize hysteresis and eddy current losses at harmonic frequencies.

E. Internal Coil Connections: Brazed or pressure type.

F. Enclosure: Class complies with NEMA 250 for the environment in which installed. Comply with NEMA ST 20.

G. Nameplates: Include transformer connection data and overload capacity based on rated allowable temperature rise.

H. Basic Impulse Level: 10 kV for transformers less than 300 kVA.

2.3 ENERGY EFFICIENT LIGHTING AND DISTRIBUTION TRANSFORMERS

A. General

1. Unless noted on Contract Drawings, all dry type transformers will be energy efficient transformers per NEMA TP1, with primary and secondary voltages of 600 V and less and capacity ratings 15kVA through 750kVA.

B. Standards

1. Transformers 750kVA and smaller shall be listed by Underwriters Laboratories.

2. Conform to the requirements of ANSI/NFPA 70.

3. Transformers are to be manufactured and tested in accordance with NEMA ST20.

4. Transformers losses shall conform to NEMA TP1 requirements.

5. Transformers losses shall be tested in accord with NEMA TP2 procedures.

C. Manufacturers

1. Approved manufacturers shall be registered firms in accordance with ISO 9001:1994 SIC3612 (US); which is the design and manufacture of low voltage thy type power, distribution and specialty transformers.

D. Ratings Information

1. All insulating materials are to exceed NEMA ST20 standards and be rated for 220degrees C UL component recognized insulation system.

2. Transformers 15kVA and larger shall be 150 degrees C temperature rise above 40 degrees C ambient. Transformers 25kVA and larger shall have a minimum of 4 2.5% full capacity primary taps. Exact voltages and taps to be as designated on the plans or the transformer schedule.

3. The maximum temperature of the top of the enclosure shall not exceed 50 degrees C rise above a 40 degrees C ambient.

4. Transformers shall be low loss type with minimum efficiencies per NEMA TP1 when operated at 35% of full load capacity. Efficiency shall be tested in accord with NEMA TP2.

E. Construction

1. Transformer coils shall be of continuous wound copper construction and shall be impregnated with nonhygroscopic, thermosetting varnish.

2. All cores to be constructed with low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below the saturated point to prevent core overheating. Cores for transformers greater than 500kVA shall be clamped utilizing insulated bolts through the core laminations to ensure proper pressure throughout the length of the core. The completed core and coil shall be bolted to the base of the enclosure; but isolated by means of rubber vibration-absorbing mounts. There shall be no metal-to-metal contact between the core and coil and the enclosure except for a flexible safety ground strap. Sound isolation systems requiring the complete removal of all fastening devices will not be acceptable.

3. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable UL and NEC standards.

4. The transformer enclosures shall be ventilated and be fabricated of heavy gauge, sheet steel construction. The entire enclosure shall be finished utilizing a continuous process consisting of degreasing, cleaning and phosphatizing, followed by electrostatic deposition of polymer polyester powder coating and baking cycle to provide uniform coating of all edges and surfaces. The coating shall be UL recognized for outdoor use. The coating color shall be ANSI 49.

F. Sound Levels

1. Sound levels shall be warranted by the manufacturer not to exceed the following: 15 to 50 KVA -45dB; 51 to 150kVA — 50dB; 151 to 300kVA — 55dB; 301 to 500kVA — 60dB; 501 to 700kVA — 62dB; 701 to 1000kVA — 64dB; 1001 to 1500kVA — 65dB; 1501 to 2000kVA — 66dB

2.4 CONTROL AND SIGNAL TRANSFORMERS

A. Units comply with NEMA ST 1 and are listed and labeled as complying with UL 506.

B. Ratings: Continuous duty. If rating is not indicated, provide capacity exceeding peak load by 50 percent minimum.

C. Description: Self-cooled, 2 windings.

2.5 FINISHES

A. Indoor Units: Manufacturer's standard paint over corrosion-resistant pretreatment and primer.

B. Outdoor Units: Comply with ANSI C57.12.28.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with safety requirements of IEEE C2.

B. Arrange equipment to provide adequate spacing for access and for circulation of cooling air.

C. Identify transformers and install warning signs according to Division 26 Section, "Electrical Identification".

D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

E. Install transformers in accordance with NECA SI, as indicated on the Drawings, and Manufacturer's published instructions, at locations as indicated on the Drawings.

1. Use Manufacturer-approved mounting brackets for transformers supported from building structure.

2. Securely anchor transformers to concrete pad for floor-mounted transformers.

3. Provide working clearances in conformance with NFPA 70.

4. Provide both primary and secondary protection using fuses or circuit breakers as indicated on the Drawings.

F. Set transformers plumb and level.

G. Use minimum two (2) foot length flexible conduit for connections to transformer case. Make conduit connections to side panel of enclosure.

H. Mount transformers on vibration isolating pads suitable for isolating transformer noise from building structure.

I. Provide minimum 4-inch high concrete pad for floor-mounted transformers. Refer to Division 26 Section, "Common Work Results for Electrical" for installation requirements.

J. Verify mounting supports are properly sized and located, including concealed bracing in walls.

3.2 GROUNDING

A. Separately Derived Systems: Comply with NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near the transformer. The neutral point of each transformer secondary shall be connected to the grounding system.

B. Comply with Division 26 Section, "Grounding and Bonding" for materials and installation requirements.

C. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Provide services of an independent electrical testing agency to perform tests on installations made under this section.

B. Test Objectives: To ensure transformer is operational within industry and manufacturer's tolerances, is installed according to the Contract Documents, and is suitable for energizing.

C. Test Labeling: On satisfactory completion of tests for each transformer, attach a dated and signed *Satisfactory Test* label to tested component.

D. Schedule tests and provide notification at least 7 days in advance of test commencement.

E. Report: Submit a written report of observations and tests. Report defective materials and installation.

F. Tests: Include the following minimum inspections and tests according to manufacturer's written instructions. Comply with IEEE C57.12.91 for test methods and data correction factors.

1. Inspect accessible components for cleanliness, mechanical and electrical integrity, and damage or deterioration. Verify that temporary shipping bracing has been removed. Include internal inspection through access panels and covers.

2. Inspect bolted electrical connections for tightness according to manufacturer's published torque values or, if not available, those specified in UL 486A and UL 486B.

3. Insulation Resistance: Perform megohmmeter tests of primary and secondary winding to winding and winding to ground.

a. Minimum Test Voltage: 1000 V, dc.

b. Minimum Insulation Resistance: 500 megohms.

c. Duration of Each Test: 10 minutes.

d. Temperature Correction: Correct results for test temperature deviation from 20 degrees C standard.

G. Test Failures: Compare test results with specified performance or manufacturer's data. Correct deficiencies identified by tests and retest. Verify that transformers meet specified requirements.

3.4 CLEANING

A. On completion of installation, inspect components. Remove paint splatters and other spots, dirt, and debris. Repair scratches and mars on finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

3.5 ADJUSTING

A. After installing and cleaning, touch up scratches and mars on finish to match original finish.

B. Adjust transformer taps to provide optimum voltage conditions at utilization equipment throughout normal operating cycle of facility. Record primary and secondary voltages and tap settings and submit with test results.

C. Adjust buck-boost transformer connections to provide optimum voltage conditions at utilization equipment throughout normal operating cycle of facility.

D. Occupancy Adjustments: When requested within twelve (12) months of date of Substantial Completion, provide on-site assistance in readjusting transformer tap settings to suit actual occupied conditions. Provide up to two (2) visits to Project site for this purpose without additional cost.

1. Voltage Recordings: Contractor performed. Provide up to 48 hours of recording on the low-voltage system of each medium-voltage transformer.

2. Point of Measurement: Make voltage recordings at load outlets selected by Owner.

END OF SECTION 261216

SECTION 262413 - SWITCHBOARDS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes service and distribution switchboards rated 600 V and less.

B. Related Sections include the following:

1. Division 16 Section, *Common Work Results for Electrical* for general and installation materials and methods.

2. Division 16 Section, *Electrical Identification* for identification materials.

1.3 SUBMITTALS

A. Product Data: For each product and component specified.

B. Shop Drawings: For each switchboard, show dimensioned plans and elevations, including required clearances and service space, component and device lists, and a single-line diagram showing main- and branch-bus current ratings and short-time and short-circuit ratings of switchboard. Include the following:

1. Wiring Diagrams: Details of wiring for power and control and differentiating between manufacturer-installed and field-installed wiring.

C. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

D. Reports of Field Tests and Observations: Certified by Contractor.

E. Maintenance Data: For switchboards to include in the maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

A. Listing and Labeling: Provide switchboard assemblies specified in this Section that are listed and labeled.

1. The Terms *Listed* and *Labeled:* As defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A *Nationally Recognized Testing Laboratory* as defined in OSHA Regulation 1910.7.

B. Comply with NFPA 70.

C. Comply with NEMA PB 2/PB2.1/PB2.2.

D. Comply with UL 891. Equipment shall be UL labeled and service entrance labeled.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver in shipping splits of lengths that can be moved past obstructions in delivery path.

B. Store so condensation will not occur on or in switchboards. Provide temporary heaters as required to avoid condensation.

C. Handle switchboards according to NEMA PB 2.1. Use only factory-installed lifting provisions.

1.6 PROJECT CONDITIONS

A. Verify dimensions by field measurements.

B. Determine suitable path for moving switchboard into place considering Project conditions.

C. Verify NEC and all Code clearance requirements. Locate switchboard to meet installation tolerances.

D. Revise locations and elevations from those indicated as required to suit Project conditions.

1.7 WARRANTY

A. Manufacturer shall warrant equipment to be free from defects in materials and workmanship for the lesser of one (1) year from date of installation or eighteen (18) months from date of purchase.

1.8 LEED REQUIREMENTS

A. Refer to Division 1 Section LEED Requirements for description of work under this Division affected by LEED requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, supply equipment from one of the following manufacturers: No other manufacturers are acceptable.
1. Square D Company.

2. Eaton Corporation; & Cutler-Hammer Products.

3. General Electric

2.2 MANUFACTURED 'UNITS

A. Front-Accessible Switchboard: Front and rear aligned, with features as follows:

1. Main Device: Individually fixed and panel mounted.

2. Branch Devices: Individually fixed and panel mounted.

B. Ratings: Provide nominal system voltage, continuous main-bus amperage, and short-circuit current ratings as indicated.

2.3 FABRICATION AND FEATURES

A. Enclosure Finish for Indoor Units: A minimum of one (1) coat of factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

B. Hinged Front Panels: Allow access to breaker, metering, accessory, and blank compartments.

C. Buses and Connections: 3 phase, 4 wire, except as otherwise indicated. Features as follows:

1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity.

2. Provide mechanical lugs to accommodate the conductors shown on the Contract Drawings.

3. Ground Bus: 1/4-by-2-inch minimum size, drawn-temper copper of 98 percent conductivity; equipped with pressure connectors for feeder- and branch-circuit ground conductors. Provide ground lug and ground bus firmly secured to each vertical section structure and shall extend the entire length of the switchboard.

4. Contact Surfaces of Buses: Silver plated.

5. Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity the entire length of the switchboard main and distribution sections. Provide for future extensions from both ends.

6. Neutral Buses: 100 percent of the ampacity of the phase buses, except as indicated, and equipped with approved pressure connectors for outgoing circuit neutral cables.

D. Expansion Provisions: The switchboard shall be designed for future expansion, with full size horizontal bussing throughout and extension stub-outs. Coordinate bus short circuit

rating with available fault current. Size in accordance with NEMA PB.2.

2.4 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: NEMA AB I, handle lockable.

1. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting capacity rating to meet available fault current.

2. Application Listing: Appropriate for application, including switching fluorescent lighting loads or heating, air-conditioning, and refrigerating equipment.

3. Lugs: Mechanical lugs for number, size, and material of conductors indicated.

2.5 INCOMING MAIN SECTION DEVICE

A. Main Circuit Breaker(s)

1. Electronic trip molded case standard function 1801% rated circuit breaker(s) through 2500A.

a. All electronic circuit breakers shall have the following time/current response adjustments: Long Time Pickup, Long Time Delay, Short Time Pickup, Short Time adjustment shall have discrete settings (fully adjustable) and shall be independent of all other adjustments.

b. Circuit breaker trip system shall be microprocessor-based true rms sensing designed with sensing accuracy through the thirteenth (13^{1h}) harmonic. Sensors ampere ratings shall be as indicated on the associated schedule or drawing.

c. Long time pickup indication to signal when loading approaches or exceeds the adjustable ampere rating of the circuit breaker shall be provided.

2.6 DISTRIBUTION SECTION DEVICES

A. Group Mounted Thermal Magnetic Circuit Breakers through 1200A.

1. Circuit breaker(s) shall be group mounted plug-on with mechanical restraint on a common pan or rail assembly.

2. The interior shall have three flat bus bars stacked and aligned vertically with glass reinforced polyester insulator laminated between phases. The molded polyester insulators shall support and provide phase isolation to the entire length of bus.

3. Circuit breaker(s) equipped with line terminal jaws shall not require additional external mounting hardware. Circuit breaker(s) shall be held in mounted

position by a self-contained bracket secured to the mounting pan by fasteners. Circuit breaker(s) of different frame sizes shall be capable of being mounted across from each other.

4. Line side circuit breaker connections are to be jaw type.

5. All unused spaces provided, unless otherwise specified, shall be fully equipped for future devices, including all appropriate connectors and mounting hardware.

B. Individually Mounted Circuit Breakers Greater than 1200A.

1. Thermal magnetic molded case circuit breaker(s) through 1500A.

a. Molded case circuit breakers shall have integral thermal and instantaneous magnetic trip in each pole. Ampere ratings shall be as shown on the drawings.

2.7 ELECTRONIC METER WITH DIGITAL DISPLAY

A. Three-phase electronic type suitable for connection to three (3) and four (4) wire circuits with the following features:

1. Meter shall be capable of measuring amperes (A), volts (V), power factor (PF), kilowatts (kW), kilowatt demand (kWd), kilovolt-amperes (KVA), kilovolt-amperes demand (kVAd), kilowatt-hours (kWh), kilovolt-ampere hours (kVAh), and Total Harmonic Distortion (THD).
2. Meter shall be equipped with a minimum of one (1) RS-485 Modbus communication port, one (1) digital input, one (1) KY-type digital output, and one (1) analog output.
3. Meter shall be equipped with high-visibility, anti-glare, backlit LCD display offering multiphase measurements, summary services, bar charts, intuitive navigation and selectable languages.
4. Measurements shall meet the accuracy requirements of IEC 62053-22 Class 0.5S and ANSI C12.20 Class 0.5S.
5. Meter shall be equipped with non-volatile on-board memory for capable of extensive logging of min/max values, energy and demand, maintenance data, alarms and any measured parameters.
6. Meter shall provide custom alarming with time stamping.
7. Meter shall be equipped with two MOD-BUS serial ports and one ethernet port; ethernet port shall be interfaced with building's data network to provide e-mail on alarm to the Owner.
8. Current transformers shall be Square D Type 100R or approved equal.
9. Potential transformers shall be provided where 277/480V metering is required, unless electronic meter is DIN rail compatible and is mounted directly to the switchboard bussing.

B. Electronic meters shall be Square D Company, PowerLogic PM 820 Series, or approved equal by acceptable manufacturer.

2.8 METERING TRANSFORMERS

A. Manufacturer: Shall be Square D Company.

B. Current Transformers: ANSI C57.13.5 ampere secondary.

C. Voltage Transformers: ANSI C57.13;120 V single secondary, (Not required for type PM meters).

DESIGNER NOTE: Are you specifying standalone Surge Protective Device under Section *Surge Protective Device?* If so, do you need paragraph 2.9?

2.9 SURGE PROTECTIVE DEVICES

A. Description: Surge Protective Devices (SPDs) installed in switchboards.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D Company - "IMA" Series (Basis of Design)
2. Eaton Corporation; Cutler-Hammer Products
3. Siemens Energy & Automation, Inc.

C. The manufacturer of the SPD shall be the same as the manufacturer of the electrical distribution equipment in which the SPDs are installed and shipped.

D. Standards - Most recent editions of:

1. Underwriters Laboratories:
   a. UL 1449 - "Surge Protective Devices"
   b. UL 1283 - "Electromagnetic Interference Filters"

2. ANSUIEEE C62.41.1-2002, C62.41.2-2002, C62.45-2002

3. National Electrical Code: Article 285 - "Surge Protective Devices, 1 kV or Less"

E. Listing Requirements:

1. SPD shall bear the UL Mark and shall be Listed to most recent editions of UL 1449 and UL 1283. "Manufactured in accordance with" is not equivalent to UL Listing and does not meet the intent of this Specification.

F. SPD shall be UL labeled with 200kA Short Circuit Current Rating (SCCR). Fuse ratings shall not be considered in lieu of demonstrated withstand testing of SPD, per 2008 NEC Article 285.6

G. SPD shall be UL labeled as Type 1, intended for use without need for external or supplemental overcurrent controls. Every suppression component of every mode, including Neutral-Ground (N-G), shall be protected by internal overcurrent and thermal overtemperature controls.

H. SPD shall be UL labeled with 20kA I-nominal (I-n) for compliance to UL 96A - "Installation Requirements for Lightning Protection Systems" for Master Label Certificate, and NFPA 780 - "Standard for the Installation of Lightning Protection Systems."

I. Minimum surge current capability (single pulse rated) per phase shall be as follows:

1 . Service-Entrance Equipment: 320kA
2 . Distribution Panelboards: 240kA
3 . Branch Panelboards: 120kA

J. SPD shall provide surge current paths for all modes of protection: Line-Neutral (L-N), Line-Ground (L-G), and Neutral-Ground (N-G) for Wye systems; Line-Line (L-L), and Line-Ground (L-G) in Delta and impedance grounded Wye systems.

K. UL 1449 Listed Voltage Protection Ratings (VPRs) shall not exceed the following:

System Voltage	L-N	L-G	L-L	N-G
208Y/120V	700V	700V	1200V	700V
480Y/277V	1200V	1200V	1800V	1200V

L. UL 1449 Listed Maximum Continuous Operating Voltage (MCOV):

System Voltage	MCOV	Allowable System Voltage Fluctuation (%)
208Y/120V	150V	25%
480Y/277V	320V	15%

M. SPD shall be constructed of one self-contained suppression module per phase.

N. Visible indication of proper SPD connection and operation shall be provided. SPD shall include LED indicator lights which shall indicate which phase as well as which module is fully operable. The status of each SPD module shall be monitored on the front cover of the enclosure as well as on the module.

0. A push-to-test button shall be provided to test each phase indicator. Push-to-test button shall activate a state change of dry contacts for testing purposes.

P. SPD shall be equipped with an audible alarm which shall activate when any one of the surge current modules has reached an end-of-life condition. An alarm on/off switch shall be provided to silence the alarm. The switches and alarm shall be located on the front cover of the enclosure.

Q. A connector shall be provided along with dry contacts (normally open or normally closed) to allow connection to a remote monitor or other system. The output of the dry contacts shall indicate an end-of-life condition for the complete SPD or module.

R. Terminals shall be provided for necessary power and ground connections.

S. A transient voltage surge counter shall be located on the diagnostic panel on the front cover of the enclosure. The counter shall be equipped with a manual reset and battery backup to retain memory loss upon loss of AC power.

T. SPD shall have a warranty period of ten (10) years from date of invoice. Warranty shall be the responsibility of the electrical distribution equipment manufacturer and shall be supported by their respective field service division.]

2.10 IDENTIFICATION

A. Nameplates and label products are specified in Division 16 Section, *Electrical Identification.*

B. Compartment Nameplates: Engraved laminated-plastic or metal nameplate for each compartment, mounted with corrosion-resistant screws.

C. Nameplates: Engraved nameplates with 1/4" high white lettering shall be furnished for all mains and feeder circuits including control fuses and also for all indicating lights and instruments. Nameplates shall give item designation and circuit number as well as frame size and appropriate trip rating. Furnish Master Nameplate giving switchboard designation, voltage ampere rating, short circuit rating, manufacturer's name, general order number and item number.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive switchboard for compliance with installation tolerances and other conditions affecting performance of switchboards.

1. Do not proceed with installation until unsatisfactory conditions have been corrected.

2. Verify dimensions of switchboard and working space clearances.

3.2 INSTALLATION

A. Install switchboards level and plumb as indicated, according to manufacturer's written instructions and NEMA PB 2.1.

B. Support switchboards on concrete housekeeping bases, 4-inch (100-mm) nominal thickness.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets

and temporary blocking of moving parts from switchboard units and components.

D. Operating Instructions: Frame and mount printed, basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on the front of switchboards.

3.3 CONNECTIONS

A. Connect switchboards and components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten electrical connectors and terminals, including screws and bolts, according to manufacturer's published torque tightening values. Use a calibrated torque wrench. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 IDENTIFICATION

A. Identify field-installed wiring and components and provide warning signs as specified in Division 16 Section, *Electrical Identification.*

B. Install compartment nameplates.

C. Contractor shall provide a framed record drawing indicating final arrangement and modifications and capacities of switchboard and electrical system one-line for easy reference. Mount on switchboard room wall. Contractor shall provide record drawing.

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Make insulation-resistance tests of each switchboard bus, component, and connecting supply, feeder, and control circuits.

2. Make continuity tests of each circuit.

B. Acceptance Testing: After installing switchboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Sections 7.1, 7.5, 7.6, 7.9, 7.10, 7.11, and 7.14 as appropriate. Certify compliance with test parameters and submit all test results for review and approval. Include test results in O&M Manual.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.

3. Measure resistance of switchboard insulation.

4. [Provide ground fault testing in accordance with NETA ATS1

3.6 ADJUSTING

A. Set field-adjustable [switches and] circuit-breaker trip ranges as indicated [recommended in coordination study]**.**

3.7 CLEANING

A. Upon completion of installation, inspect interior and exterior of switchboards. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262413

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes lighting and power panelboards and associated auxiliary equipment rated 600 V and less.

B. Panelboards may be series rated for the AIC identified. Documentation must be provided to support series ratings with submittal package.

C. Related Sections include the following:

1. Division 26 Section, *Common Work Results for Electrical* for general materials and installation methods.

2. Division 26 Section, *Electrical Identification* for labeling materials.

1.3 SUBMITTALS

A. Product Data: For each type of panelboard, accessory item, and component specified.

B. Shop Drawings: For panelboards. Include dimensioned plans, sections, and elevations. Show tabulations of installed devices, major features, and voltage rating. Include the following:

1. Enclosure type with details for types other than NEMA 250, Type 1.

2. Bus configuration and current ratings.

3. Short-circuit current rating of panelboard.

4. Features, characteristics, ratings, and factory settings of individual protective devices and auxiliary components.

5. Wiring Diagrams: Details of schematic diagram including control wiring and differentiating between manufacturer-installed and field-installed wiring.

C. Qualification Data: For firms and persons specified in *Quality Assurance* Article.

D. Field Test Reports: Indicate and interpret test results for compliance with

performance requirements.

E. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

F. Maintenance Data: For panelboard components to include in the maintenance manuals specified in Division 1.

G. Project Record Data: Record actual locations of products, indicate actual branch circuit arrangement.

1.4 QUALITY ASSURANCE

A. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms *Listed* and *Labeled:* As defined in the National Electrical Code, Article 100.

2. Listing and Labeling Agency Qualifications: A *Nationally Recognized Testing Laboratory* as defined in OSHA Regulation 1910.7.

B. Comply with NFPA 70.

C. Comply with NEMA AB1, *Molded Case Circuit Breakers.*

D. Comply with NEMA PB1, *Panelboards.*

E. Comply with NEMA PB1.1, *Instructions for Safe Installation, Operation & Maintenance of Panelboards Rated 600 Volts or Less.*

1.5 EXTRA MATERIALS

A. Keys: 2 spares of each type for panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, supply equipment from one of the following manufacturers; no other manufacturers are acceptable.

1. Square D Company. (Basis of Design)

2. Eaton Corp.; Cutler-Hammer Products.

3. Siemens Energy & Automation Inc.

2.2 PANELBOARD FABRICATION

A. Enclosures: Flush- or surface-mounted cabinets as indicated. NEMA PB I, Type 1, unless otherwise indicated to meet environmental conditions at installed location.

B. Front: Secured to box with concealed trim clamps, unless otherwise indicated. Front for surface-mounted panelboards shall be same dimensions as box. Fronts for flush panelboards shall overlap box, unless otherwise indicated.

C. Directory Frame: Clear plastic cardholder, mounted inside each panelboard door.

D. Bus: Hard drawn copper of 98 percent conductivity.

E. Main and Neutral Lugs: Provide mechanical lugs to accommodate the conductors shown on the Contract Drawings.

F. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors. Bonded to box.

G. Service Equipment Approval: Listed for use as service equipment for panelboards with main service disconnect.

H. Future Devices: Equip with mounting brackets, bus connections, and necessary appurtenances, for the over-current protective device ampere ratings indicated for future installation of devices.

Special Features: Include the following features for panelboards as indicated:

1. Hinged Front Cover: Entire front trim hinged to box with standard door within hinged trim cover.

2. Gutter Barrier: Arranged to isolate section of gutter as indicated.

3. Column-Type Panelboard Configuration: Narrow cabinet extended as wireway to overhead junction box equipped with ground and neutral terminal buses.

4. Subfeed: Over-current protective device or lug provision as indicated.

5. Feed-Through Lugs: Sized to accommodate feeders indicated.

2.3 POWER DISTRIBUTION PANELBOARDS

A. Interior

1. Basis of design is Square D I-Line type. Continuous main current ratings as indicated on Contract Drawings not to exceed 1200 amperes maximum. Panelboard bus current ratings shall be determined by heat-rise tests in accordance with UL 67.

2. Provide UL listed short circuit current ratings (SCCR) as indicated on the

contract drawings, not to exceed the lowest interrupting capacity rating of any circuit breaker installed with a maximum of 200,000 RMS symmetrical amperes. Main lug and main breaker panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Articles 230.VI and VII.

3. The panelboard interior shall have three flat bus bars stacked and aligned vertically with glass reinforced polyester insulators laminated between phases. The molded polyester insulators shall support and provide phase isolation to the entire length of bus.

4. The bussing shall be fully rated with sequentially phased branch distribution. Bus bar plating shall run the entire length of the bus bar. The entire interleaved assembly shall be contained between two (2) U-shaped steel channels, permanently secured to a galvanized steel mounting pan by fasteners.

5. Interior trim shall be of dead-front construction to shield user from all energized parts. Main circuit breakers through 800 amperes shall be vertically mounted. Main circuit breaker and main lug interiors shall be field convertible for top or bottom incoming feed.

6. A solidly bonded equipment ground bar shall be provided.

7. Solid neutral shall be equipped with a full capacity bonding strap for service entrance applications. Gutter mounted neutral will not be acceptable.

B. Group Mounted Circuit Breakers Through 1200A

1. Circuit breaker(s) shall be group mounted plug-on with mechanical restraint on a common pan or rail assembly.

2. Circuit breakers equipped with line terminal jaws shall not require additional external mounting hardware. Circuit breakers shall be held in mounted position by a self-contained bracket secured to the mounting pan by fasteners. Circuit breakers of different frame sizes shall be capable of being mounted across from each other.

3. All unused spaces provided, unless otherwise specified, shall be fully equipped for future devices, including all appropriate connectors and mounting hardware.

4. Furnish thermal magnetic molded case circuit breakers for 250A frames and below.

C. Thermal Magnetic Molded Case Circuit Breakers

1. Molded case circuit breakers shall have integral thermal and instantaneous magnetic trip in each pole.

2. Circuit breakers shall have interrupting ratings as shown on the

contract drawings, but not less than 18,000 AIC rms symmetrical amperes at rated voltage. Ampere ratings shall be as shown on the drawings.

D. Enclosures

1. Type **1** Boxes

a). Boxes shall be galvanized steel constructed in accordance with UL 50 requirements. Zinc-coated galvanized steel will not be acceptable.

b). Boxes shall have removable blank end walls and interior mounting studs. Interior support bracket shall be provided for ease of interior installation.

2. Type 1 Trim Fronts

a). Trim front steel shall meet strength and rigidity requirements per UL 50 standards. Shall have an ANSI 49 medium gray enamel electrodeposited over cleaned phosphatized steel.

b). Trim front door shall have rounded corners and edges free of burrs.

c). Locks shall be cylindrical tumbler type with larger enclosures requiring sliding vault locks with 3-point latching. All lock assemblies shall be keyed alike.

2.4 LIGHTING AND APPLIANCE PANELBOARDS

A. Interior

1. Minimum short circuit current ratings as shown on the Contract Drawings, but not less than 10,000 AIC rms symmetrical amperes for 120/208V panelboards, and 22,000 AIC rms symmetrical amperes for 277/480V panelboards. Basis for design is Square D NQ 120/208V and NF (277/480V).

2. Provide one (1) continuous bus bar per phase. Each bus bar shall have sequentially phased branch circuit connectors suitable for plug-on or bolt-on branch circuit breakers. The bussing shall be fully rated. Panelboard bus current ratings shall be determined by heat rise tests conducted in accordance with UL 67. Bus bar plating shall run the entire length of the bus bar. Panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Articles 230-F and — G.

3. All current carrying parts shall be insulated from ground and phase to phase by high dielectric strength thermoplastic.

4. Interior trim shall be of dead front construction to shield user from energized parts. Dead front trim shall have preformed twist-outs covering unused

mounting space.

5. Interiors shall be field convertible for top or bottom incoming feed. Main circuit breakers in 100A interiors shall be horizontally mounted. Main circuit breakers over 100A shall be vertically mounted. Sub-feed circuit breakers shall be vertically mounted. Main lug interiors up to 400 amperes shall be field convertible to main breaker. Interior leveling provisions shall be provided for flush mounted applications.

B. Main Circuit Breaker

1. Main circuit breakers shall have an over-center, trip free, toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have a permanent trip unit with thermal and magnetic trip elements in each pole. Each thermal element shall be true rms sensing and be factory calibrated to operate in a 40 degrees C ambient environment. Thermal elements shall be ambient compensating above 40 degrees C.

2. Two and three pole circuit breakers shall have common tripping of all poles. Circuit breakers frame sizes above 100 amperes shall have a single magnetic trip adjustment located on the front of the circuit breaker that allows the user to simultaneously select the desired trip level of all poles. Circuit breakers shall have a push to trip button for maintenance and testing purposes.

3. Breaker handle and faceplate shall indicate rated ampacity. Standard construction circuit breakers shall be UL listed for reverse connection without restrictive line or load markings.

C. Branch Circuit Breakers

1. Molded case branch circuit breakers shall have bolt-on type bus connectors.

2. Circuit breakers shall have an over-center toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have thermal and magnetic trip elements in each pole. Two and three pole circuit breakers shall have common tripping of all poles.

3. There shall be two forms of visible trip indication. The breaker handle shall reside in a position between ON and OFF. In addition, there shall be a red VISI TRIP indicator appearing in the clear window of the circuit breaker housing.

D. Enclosures

1. Type 1 Boxes

a). Boxes shall be galvanized steel constructed in accordance with UL 50 requirements. Galvanized steel will not be acceptable.

b). Boxes shall have removable end-walls with knockouts located on one end. Boxes shall have welded interior mounting studs.

2. Type 1 Fronts

a). Fronts shall meet strength and rigidity requirements per UL 50 standards. Front shall have ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.

b). Panelboards shall have MONO-FLAT fronts with concealed door hinges and mounted with trim screws. Front shall not be removable with the door locked. Doors on front shall have rounded corners and edges shall be free of burrs.

2.5 PANELBOARD SURGE PROTECTIVE DEVICES

A. Description: Integrated Surge Protective Devices (SPDs) in panelboards.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D Company - "IMA" Series (Basis of Design)
2. Eaton Corporation; Cutler-Hammer Products
3. Siemens Energy & Automation, Inc.

C. The manufacturer of the SPD shall be the same as the manufacturer of the electrical distribution equipment in which the SPDs are installed and shipped.

D. Standards - Most recent editions of:

1. Underwriters Laboratories:
   a). UL 1449 - "Surge Protective Devices"
   b). UL 1283 - "Electromagnetic Interference Filters"

2. ANSI/IEEE C62.41.1-2002, C62.41.2-2002, C62.45-2002

3. National Electrical Code: Article 285 - "Surge Protective Devices, 1 kV or Less"

E. Listing Requirements:

SPD shall bear the UL Mark and shall be Listed to most recent editions of UL 1449 and UL 1283. "Manufactured in accordance with" is not equivalent to UL Listing and does not meet the intent of this Specification.

F. SPD shall be UL labeled with 200kA Short Circuit Current Rating (SCCR). Fuse ratings shall not be considered in lieu of demonstrated withstand testing of SPD, per 2008 NEC Article 285.6

G. SPD shall be UL labeled as Type 1, intended for use without need for external or supplemental overcurrent controls. Every suppression component of every mode, including Neutral-Ground (N-G), shall be protected by internal overcurrent and thermal overtemperature controls.

H. SPD shall be UL labeled with 20kA I-nominal (I-n) for compliance to UL 96A - "Installation Requirements for Lightning Protection Systems" for Master Label Certificate, and NFPA 780 - "Standard for the Installation of Lightning Protection Systems."

I. Minimum surge current capability (single pulse rated) per phase shall be as follows:

1. Service-Entrance Equipment: 320kA
2. Distribution Panelboards: 240kA
3. Branch Panelboards: 120kA

J. SPD shall provide surge current paths for all modes of protection: Line-Neutral (L-N), Line-Ground (L-G), and Neutral-Ground (N-G) for Wye systems; Line-Line (L-L), and Line-Ground (L-G) in Delta and impedance grounded Wye systems.

K. UL 1449 Listed Voltage Protection Ratings (VPRs) shall not exceed the following:

System Voltage	L-N	L-G	L-L	N-G
208Y/120V	700V	700V	1200V	700V
480Y/277V	1200V	1200V	1800V	1200V

L. UL 1449 Listed Maximum Continuous Operating Voltage (MCOV):

System Voltage	MCOV	Allowable System Voltage Fluctuation (%)
208Y/120V	150V	25%
480Y/277V	320V	15%

M. SPD shall be constructed of one self-contained suppression module per phase.

N. Visible indication of proper SPD connection and operation shall be provided. SPD shall include LED indicator lights which shall indicate which phase as well as which module is fully operable.

The status of each SPD module shall be monitored on the front cover of the enclosure as well as on the module.

0. A push-to-test button shall be provided to test each phase indicator. Push-to-test button shall activate a state change of dry contacts for testing purposes.

P. SPD shall be equipped with an audible alarm which shall activate when any one of the surge current modules has reached an end-of-life condition. An alarm on/off switch shall be provided to silence the alarm. The switches and alarm shall be located on the front cover of the enclosure.

Q. A connector shall be provided along with dry contacts (normally open or normally closed) to allow connection to a remote monitor or other system. The output of the dry contacts shall indicate an end-of-life condition for the complete SPD or module.

R. Terminals shall be provided for necessary power and ground connections.

S. A transient voltage surge counter shall be located on the diagnostic panel on the front

cover of the enclosure. The counter shall be equipped with a manual reset and battery backup to retain memory loss upon loss of AC power.

T. SPD shall have a warranty period of ten (10) years from date of invoice. Warranty shall be the responsibility of the electrical distribution equipment manufacturer and shall be supported by their respective field service division.]

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessory items according to NEMA PB 1.1.

B. Mounting: Plumb and rigid without distortion of box. Mount flush panelboards uniformly flush with wall finish.

C. Install filler plates in unused spaces.

D. Provision for Future Circuits at Flush-Mounted Panelboards: Stub 1-inch (25 mm) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future and/or 1-inch (25 mm) empty conduits into raised floor space or below slab not on grade, in accordance with the following schedule:

Total Number of Single Pole Spares and Spaces	Number of 1-inch Empty
1—3	Two
4—6	Three
7—9	Four
10—12	Five
13—20	Ten
21—32	Fifteen

E. Wiring in Panelboard Gutters: Arrange conductors into groups, and bundle and wrap with wire ties after completing load balancing.

F. Two or three pole circuit breakers shall be common trip type. Single pole breakers with handle ties will not be permitted.

G. Tandem circuit breakers will not be permitted.

H. Multiple-section panelboards, as required by number of branch circuit breakers, shall consist of two or more cabinets with identical interiors mounted under separate trims. Cabinets, trims, and doors shall be the same size. Main lugs and busses of each section shall be rated as indicated on the drawings. Where main breakers are indicated in multi-section panelboards the main breaker shall be contained in one section with through-feed lugs and sub-feed cables installed within

panel, equal to the incoming feeder size. All busses and lugs shall have ampere capacity equal to or greater than the main breaker ampere rating. Loads shall be divided as evenly as practical between the sections in addition to being balanced over the phases.

I. Provide ground buses in panelboards as indicated on the Drawings. Ground bus shall be similar in all respects to neutral bus.

J. Ground Fault Protection: Install panelboard ground fault circuit interrupter devices in accordance with installation guidelines of NEMA 289, *Application Guide for Ground Fault Circuit Interrupters.*

K. Branch circuit breakers (or switches) serving clocks, telephone and communications equipment, refrigerators, exit signs, fire alarm system controls, etc., shall be equipped with lock clips to prevent accidental operation.

L. Height: Six-feet, six-inches to top of panelboard; install panelboards taller than 6 feet with bottom no more than 4 inches above the floor. Top breaker maximum height not to exceed 6 feet 8 inches.

3.2 IDENTIFICATION

A. Identify field-installed wiring and components and provide warning signs as specified in Division 26 Section, *Electrical Identification.*

B. Panelboard Nameplates: Label each panelboard with engraved laminated-plastic or metal nameplates mounted with corrosion-resistant screws.

C. Panel Circuit Directory: Provide a typewritten directory, indicating plainly what each branch circuit of the panel serves and where. Provide additional information as required by NEC. Spaces and spare breakers shall be written in pencil. Copying of Contract Drawing Panel Schedules and Descriptions shall not be acceptable. Circuit directory shall reflect final circuit connections, loads and locations after balancing of panelboard loads.

3.3 GROUNDING

A. Make equipment grounding connections for panelboards as indicated.

B. Provide ground continuity to main electrical ground bus as indicated.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Make insulation-resistance tests of each panelboard bus, component, and

connecting supply, feeder, and control circuits.

2. Make continuity tests of each circuit.

3. Provide set of Contract Documents to test organization. Include full updating on final system configuration and parameters where they supplement or differ from those indicated in the original Contract Documents.

B. Testing: After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.

3. Reports by Testing Organization: Report written reports of tests and observations. Report defective materials and workmanship and unsatisfactory test results. Include records of repairs and adjustments made.

4. Labeling: Upon satisfactory completion of tests and related effort, apply a label to tested components indicating results of tests and inspections, responsible organization and person, and date.
5. Protective Device Ratings and Settings: Verify indicated ratings and settings to be appropriate for final system configuration and parameters. Where discrepancies are found, recommend final protective device ratings and settings. Use accepted ratings or settings to make the final system adjustments.

C. Visual and Mechanical Inspection: Include the following inspections and related work:

1. Inspect for defects and physical damage, labeling, and nameplate compliance with requirements of up-to-date drawings and panelboard schedules.

2. Exercise and perform operational tests of all mechanical components and other operable devices in accordance with manufacturer's instruction manual.

3. Check panelboard mounting, area clearances, and alignment and fit of components.

4. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.

D. Electrical Tests: Include the following items performed in accordance with manufacturer's instruction:

1. Insulation resistance test of buses and portions of control wiring that is disconnected from solid-state devices. Insulation resistance less than 100 megohms is not acceptable.

2. Ground resistance test on system and equipment ground connections.

3. Test main and subfeed over-current protective devices.

E. Retest: Correct deficiencies identified by tests and observations and provide retesting of panelboards by testing organization. Verify by the system tests that the total assembly meets specified requirements.

3.6 COMMISSIONING

A. Balancing Loads: After Substantial Completion, but not more than 2 months after Final Acceptance, conduct load-balancing measurements and make circuit changes as follows:

1. Perform measurements during period of normal working load as advised by Owner.

2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility. Make special arrangements with Owner to avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.

3. Recheck loads after circuit changes during normal load period. Record all load readings before and after changes and submit test records.

4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as required to meet this minimum requirement.

3.7 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.8 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

END OF SECTION 262416

SECTION 262713 - METERING

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.

B. See Division 26 Section, *Common Work Results for Electrical.*

C. See Division 26 Section, P*anelboards.*

1.2 SCOPE

A. Provide all equipment necessary to install electronic meters capable of measuring volts, power factor, kilowatts, kilowatt demand, amperes and thermal ampere demand for service entrance metering switchboards.

B. Existing current and potential transformers may be used if their rated burden is large enough to carry the existing plus new loads and if ratio and accuracy is appropriate. Provide third transformer if required for full readings. Test existing instrument transformers as required.

1.3 SUBMITTALS

A. Submit product data under provisions of Division 26 Section, *Common Work Results for Electrical.*

PART 2 - PRODUCTS

2.1 ELECTRONIC METER

A. Electronic meter with digital display: Three phase electronic type, rated 5 amperes and 120 volts at 60 Hertz. Meter suitable for connection to 3 and 4 wire circuits. Meter shall be capable of measuring volts, power factor, kilowatts, kilowatt demand, amperes and thermal ampere demand. Provide programmable demand indicator and KYZ pulse initiator in meter. Contact output relays shall have Form C contacts for KYZ pulse outputs, and a minimum of three (3) field selectable 4-20 milliamp analog outputs. Meters shall have a semi-flush mounted case with matching cover.

B. Electronic meters shall be Square D Power Logic, General Electric, Multilin MTM Plus, Electra Industries, or approved equal.

2.2 METERING TEST SWITCH

A. Provide ten position test switch with cover (4 potential and 6 current) ABB Type FT-1, or approved equal with each new metering installation.

2.3 CURRENT TRANSFORMERS

A. Five ampere secondary, wound, bushing, bar or window type as appropriate, with dual or multiple windings as shown on the Plans. Primary/secondary ratio as shown on the Plans, or as recommended by Coordination Study and Equipment Manufacturer. Burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

1. Ratio for dual rated CT's shall match rating of service and 1/2 rating of service (i.e., 1200/600:5 for a 1200 Amp service).

2. Dual-rated shorting terminal strip on CT wiring in metering compartment.

3. Provide shorting auxiliary contacts in test switch.

B. Dry, indoor, 600V type with accuracies in accordance with ANSI Standard C37.20 Section 20-4.63.

C. Current transformer ratios as shown on drawings.

D. Mount and brace transformers to withstand 100,000 amp short circuit current.

E. Current transformers shall be Square D Type 100R or approved equal.

2.4 POTENTIAL TRANSFORMERS

A. One hundred twenty (120) volt single secondary with fused primary and secondary, primary/secondary ratio as shown on Drawings or as recommended by Coordination Study and Equipment Manufacturer, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

1. Ratio: Shall be 2.4:1 for 3 Phase, 4 Wire wye configuration.

B. Dry, indoor, 600V type with accuracy's in accordance with ANSI standards. 10 kV (BIL).

C. Primary volts: 277 volts for 480 volt systems. Secondary volts: 120.

D. Potential transformers shall be provided where 277/480V metering is required.

E. Potential transformers shall be Square D or approved equal.

2.5 GROUND FAULT RELAY AND SENSOR:

A. Zero sequence sensor with adjustable ground fault relay. Adjustment from 100 to 1200 amperes, time delay adjustable from 0 to 15 seconds. Provide with monitor panel and lamp to indicate relay operation, "TEST" and "RESET" control switches.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The meters shall be mounted in the locations indicated on the drawings. Any existing meters shall be removed and disposed of per the Owner's instructions. All unused openings shall be covered with a plate of similar material and painted to match the existing enclosure. Any extension of wiring needed to accommodate the meters shall be done using terminal blocks and #10 AWG stranded copper wire. The wire used for the extensions shall be 600V, Type SIS insulation. Splices are not allowed.

B. Since dangerous voltage shall develop in the open circuit secondary windings of energized current transformers, de-energize the current transformers by short circuiting the secondary windings before disconnecting or connecting instruments to current transformers.

C. Meters shall generally be mounted in main switchboard**.**

D. Provide current transformer, ratio, and polarity tests.

E. Coordinate interlock requirements of demand meter with Automatic Temperature Controls System.

END OF SECTION 262713

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Straight-blade receptacles and associated device plates.
2. GFCI receptacles.
3. Locking receptacles.
4. Isolated-Ground receptacles.
5. Tamper-Resistant receptacles.
6. Weather-Resistant receptacles.
7. Toggle switches.
8. Wall-box dimmer switches.
9. Pendant cord-connector devices.
10. Cord and plug sets.
11. Emergency Pushbuttons

1.3 DEFINITIONS

A. EMI: Electromagnetic Interference.

B. GFCI: Ground-Fault Circuit Interrupter.

C. IG: Isolated-Ground.

D. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

E. RFI: Radio-Frequency Interference.

F. UTP: Unshielded Twisted Pair.

G. TR: Tamper-Resistant.

H. WR: Weather-Resistant.

1.4 SUBMITTALS

A. Product Data: For each product specified, indicating configurations, finishes, dimensions, and manufacturer's instructions.

B. Shop Drawings: Legends for receptacles and switch plates.

C. Samples: As requested for devices and device plates for color selection and evaluation of technical features.

D. Maintenance Data: For materials and products to include in maintenance manuals specified in Division 1.

1.5 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

C. Comply with NECA Standard of Installation.

D. Codes: Provide wiring devices conforming to the following:

1. American National Standards Institute (ANSI): Provide lugs and receptacle devices constructed in accordance with ANSI C73, Attachment Plugs and Receptacles, Dimensions of.

2. Institute of Electrical and Electronics Engineers (IEEE): Construct and install wiring devices in accordance with requirements of IEEE 241, *Recommended Practice for Electric Power Systems in Commercial Building.*

3. National Electrical Manufacturers Association (NEMA): Provide wiring devices constructed and configured in accordance with the requirements of

a. WD1: General Requirements for Wiring Devices

b. WD2: Semiconductor Dimmers for Incandescent Lamps

c. WD5: Special Purpose Wiring Devices

d. WD6: Wiring Devices - Dimensional Requirements.

4. National Fire protection Association (NFPA): Comply with NFPA 70, *National Electrical Code* as applicable to construction and installation of electrical wiring devices.

5. Underwriters Laboratories, Inc. (UL): Provide wiring devices which are UL listed and comply with the requirements of:

a. 5: Surface Metal Raceways and Fittings.

b. 20: General-Use Snap Switches.

c. 498: Attachments, Plugs and Receptacles

d. 514A: Metallic Outlet Boxes.

e. 514B: Fittings for Conduit and Outlet Boxes.

f. 514C: Non-Metallic Outlet Boxes, Flush-Device Boxes, and Covers

g. 943: Ground-Fault Circuit Interrupters

1.6 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Owner.

1. Telephone/Power Service Poles: One for each 10, but not less than one.

2. Floor Service-Outlet Assemblies: One for each 10, but not less than one.

3. Poke-through, Fire-Rated Closure Plugs: One for each five floor service outlets installed, but not less than two.

4. TVSS Receptacles: One for each eight installed, but not less than two.

1.8 **[LEED REQUIREMENTS**

A. Refer to Division 1 Section, "LEED Requirements" for description of work under this Division affected by LEED requirements.]

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

Wiring Devices:

a. Bryant Electric, Inc.

b. Eagle Electric Manufacturing Co., Inc.

c. GE Company; GE Wiring Devices.

d. Hubbell, Inc.; Wiring Devices Div.

e. Killark Electric Manufacturing Co.

f. Leviton Manufacturing Co., Inc.

g. Pass & Seymour/Legrand; Wiring Devices Div.

h. Pyle-National, Inc.; an Amphenol Co.

2. Wiring Devices for Hazardous (Classified) Locations:

a. Crouse-Hinds Electrical Co.; Distribution Equipment Div.

b. Killark Electric Manufacturing Co.

c. Pyle-National, Inc.; an Amphenol Co.

3. Multioutlet Assemblies:

a. Airey-Thompson Co.

b. Wiremold.

c. Hubbell Inc. Wiring Devices

d. American Electric

4. **[Poke-through,]** Floor Service Outlets **[and Telephone/Power Poles]:**

a. American Electric.

b. Hubbell, Inc.; Wiring Devices Div.

c. Pass & Seymour/Legrand; Wiring Devices Div.

d. Square D Company.

e. Wiremold.

5. Retractable Cord Reels

a. Appleton Electric Company

b. Reelcraft

c. Ericson Manufacturing Company

d. Hubbell Wiring Devices — Kellems

6. Emergency Push Buttons

a. Safety Technology International, Inc. (STI)

2.2 RECEPTACLES

A. Duplex receptacles shall be straight blade, 2 pole, 3 wire, 125 VAC, 20 ampere, specification grade, grounding type, NEMA 5-20R and shall meet Federal Specification #W-S-596d. Receptacles shall be Pass & Seymour Model No. 5362 or approved equal.

B. Clock outlets shall be straight blade, 2 pole, 3 wire, 125 VAC, 15 ampere, specification grade grounding type, NEMA 5-15R and shall be, Pass & Seymour Model No. S3733-SS with stainless steel wall plate or approved equal.

C. Ground Fault Interrupter (GFI) type, heavy duty duplex receptacles shall be feed-through, 2 pole, 3 wire, 120VAC, 20 ampere, specification grade NEMA 5-20R, UL-rated Class A, Group 1, with solid state ground-fault sensing and signaling, with a trip time of .025 seconds nominal and a trip threshold of +7- 5 mA. GFI receptacles shall be Pass & Seymour Model No. 2091-S or approved equal.

D. Isolated Ground (IG) type duplex receptacles shall be straight blade, 2 pole, 3 wire, 125 VAC, 20 ampere, specification grade, NEMA 5-20R and shall comply with Federal Specification #WC-596-F. Isolated Ground receptacles shall be clearly identified with a green isolated ground triangle, and shall be Pass & Seymour Model No. IG6300 with Type 430 stainless steel wall plate, Model No. S8-IG or approved equal.

E. Special receptacles shall be straight or locking blade, ratings and NEMA configuration as indicated on the drawings with stainless steel wallplate to match outlet type. Special receptacles shall be specification grade Pass & Seymour or approved equal.

F. All receptacles on emergency circuits shall have a red faceplate, an identification label for circuit serving receptacle, and the legend *Emergency*.

2.3 SWITCHES

A. Toggle switches shall be quiet type, AC specification grade, 120-277 volt, 20 ampere, single pole, double pole, three-way and four-way, with toggle. All switches shall be premium specification grade with separate green ground screw. Toggle switches shall be Pass & Seymour Model No. 20AC or approved equal.

B. Pilot light switches shall be quiet type, AC specification grade, 120 volt, 20 ampere, single pole, double pole and three-way with clear or red illuminated toggle. Pilot light switches shall be Pass & Seymour Model NO. 20AC-CPL and 20AC-RPL, or approved equal.

C. Key switches shall be AC specification grade, 120-277 volt, 20 ampere, single pole, double pole, three-way and four-way, with one key per switch. Key switches shall be Pass & Seymour Model No. 20AC-L, or approved equal.

D. Dimmer Switches shall be modular, full-wave, solid-state units with integral, quiet

on/off switches and audible and electromagnetic noise filters. Dimmer switches shall be sized by the Contractor to serve the load indicated on the Contract Drawings.

1. Control: Continuously adjustable slide. Single-pole or three-way switch to suit connections.

2. Incandescent Lamp Dimmers: Modular, 120 V, 60 Hz with continuously adjustable rotary knob, toggle, or slide; single pole with soft tap or other quiet switch; electromagnetic filter to eliminate noise, RF, and TV interference; and 5-inch (130-mm) wire connecting leads.

3. Fluorescent Lamp Dimmers: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming to a maximum of 1 percent of full brightness.

E. Switches on emergency and life safety circuits shall have red finish bodies.

F. Door jamb plunger switches shall be light on door open type. Plunger switches shall be Pass and Seymour Model No. 1200 or approved equal.

2.4 FINISHES

A. Wiring device catalog numbers in Section text do not designate device color. Device colors shall be as follows, unless otherwise indicated elsewhere in the Specifications and Drawings or as required by NFPA or device listing:

1. Wiring Devices connected to Normal Power System: **[Ivory] [White] [Finish selected by Architect].**

2. Wiring Devices connected to Computer Power System: **[Gray] [Ivory] [Finish selected by Architect].**

3. Wiring Devices connected to Emergency Power System: **[Red] [Ivory] [Finish selected by Architect].**

4. Special Receptacles: **[Gray] [Black] [Finish selected by Architect]**

5. Isolated Ground Receptacles: **[Orange] [Finish selected by Architect] [Shall match color of devices connected to Computer Power System].**

2.5 DEVICE PLATES

A. Device plates shall be provided for all switches and receptacles. Device plates shall be as manufactured to fit each type of single device, to fit devices which are ganged together, and they shall be by same manufacturer as wiring devices with finish as follows:

1. [Material for Finished Spaces: Steel with wrinkled finish, white baked enamel, suitable for field painting, except as otherwise indicated.]

2. [Material for Finished Spaces: 0.04-inch thick, Type 430 satin finished stainless steel.]

3. [Material for Finished Spaces: 0.04-inch-thick, Type 302, satin-finished stainless steel, except as otherwise indicated].

4. [Material for Finished Spaces: 0.04-inch-thick brushed brass with factory polymer finish, except as otherwise indicated].

5. [Material for Finished Spaces: 0.04-inch-thick brass, satin chrome-plated, except as otherwise indicated].

6. [Material for Finished Spaces: 0.05-inch-thick anodized aluminum, except as otherwise indicated].

7. [Material for Unfinished Spaces: Galvanized steel.]

8. [Color: Matches wiring device, except as otherwise indicated.]

9. [Plate-Securing Screws: Metal with heads colored to match plate finish.]

B. Material for Damp Locations: Heavy-duty die-cast zinc/aluminum construction listed and labeled for use in "wet locations." All components shall have baked-on electrostatic, polyester, power paint finish for superior corrosion resistance. Covers for receptacles shall be equipped with one or more lift cover(s) equipped with stainless steel springs. Covers for toggle switches shall be equipped with actuating levers and shall mount directly over the switch. Covers shall comply with NEC Section 406.8(A) and 406.8(B).

1. Duplex Receptacle, 2 Self-Closing Lids — Pass & Seymour Model No. CA8GH or approved equal
2. GFCI Receptacle, 1 Self-Closing Lid — Pass & Seymour Model No. CA26GH (Horizontal) and Pass & Seymour Model No. CA26GV (Vertical), or approved equal.
3. Toggle Switch — Pass & Seymour Model No. CA1GL or approved equal.
4. Toggle switch, lockable cover — Crouse-Hinds Model No. DS185, or approved equal.

C. Material for Wet Locations: Heavy-duty die-cast zinc/aluminum construction with gasketed, hinged lockable lid, designed to be weatherproof while the device is in use, and listed and labeled for use in "wet locations." All components shall have baked-on electrostatic, polyester, power paint finish for superior corrosion resistance. Covers for receptacles shall be self-closing per UL514C42.3, be equipped with stainless steel springs, and shall have a cam action latch for secure closure. Covers for toggle switches shall be equipped with actuating levers and shall mount directly over the switch. Covers shall comply with NEC Section 406.8(B) for Outdoor Wet Location covers and NEMA Standard 3R.

1. Duplex/GFCI Receptacle - Pass & Seymour Model No. WIUClOCAGH or approved equal.
2. Toggle switch — Pass & Seymour Model No. CAIGL, or approved equal.

3. Toggle switch, lockable cover — Crouse-Hinds Model No. DS105, or approved equal.

D. Device plates shall be factory labeled to clearly identify receptacles which are on emergency circuits and isolated ground receptacles.

E. Device plates for receptacles on emergency circuits shall be a red finish.

F. Provide jumbo size plates for outlets installed in masonry walls.

2.6 PROTECTIVE WIRE GUARDS

A. Provide protective wireguards over devices subject to physical damage. All devices installed in the gymnasium or on the exterior of the building shall be provided with protective guards. Protective guards shall be manufacturer's recommended product for the device being protected or a suitable guard as manufactured by American Time & Signal Company (800328-8996), Safety Technology International (STI) (800-888-4784), or Institutional Systems Services Corporation (800-524-0537).

B. Devices to be provided with protective guards include, but are not limited to, the following:

1. Clocks
2. Bell/Smoke/Heat Detectors
3. Fire Alarm Pull Stations
4. Thermostats
5. Speaker Horn
6. Fire Alarm Strobe Horn [Speaker]
7. Exit Signs
8. Emergency Lights
9. Telephones
10. Data Outlets
11. Security Devices/Motion Detectors
12. Wiring Devices
13. Emergency Shut-Off Stations
14. Other Devices as required by Owner

15. [Gymnasium Lighting Fixtures]

C. Guard shall be fabricated from'/4-inch (9-gauge) cold-rolled steel rods, welded together with mounting tabs. Guard shall be finished with a powder-based epoxy to protect against corrosion. Finish color shall match the finishes for the area being installed, except guards for fire alarm devices shall be red finish color.

D. Protective Devices shall be considered incidental to the product installed in an area subject to damage as indicated on the drawings and shall be provided at no additional cost to the Owner.

2.7 PENDANT CORD/CONNECTOR DEVICES

A. Description: Matching, locking type, plug and receptacle body connector, NEMA WD 6, Configurations L5-20P and L5-20R, Heavy-Duty grade.

1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.

2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.8 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

1. Cord: Rubber-insulated, stranded-copper conductors, with type SOW-A jacket. Green-insulated grounding conductor, and equipment-rating ampacity plus a minimum of 30 percent.

2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.9 RETRACTABLE CORD REEL WITH SINGLE RECEPTACLE OUTLET

A. Description: Factory-fabricated retractable cord reel with receptacle connector body and the following features:

1. Cord: Type "SO" cord with conductors to match requirements (voltage, ampacity, quantity) of equipment being connected.

2. Receptacle connector body: Nylon body with integral cable clamping jaws and blade configuration to match equipment being connected.

3. [Steel] [Cast aluminum] frame and steel reel sides.

4. Factory-assembled, modular type collector ring and brush block assembly.

5. Lifetime lubricated bearings.

6. Removable cover(s) for access to springs and ring/brush assembly.

7. Adjustable, four-roller cord outlet guide.

8. Built-in cord locking ratchet to hold cord at desired length. Ratchet can be disengaged to provide constant cord tension.

2.10 RETRACTABLE CORD REEL WITH OUTLET BOX WITH GFCI RECEPTACLE

A. Description: Factory-fabricated retractable cord reel with duplex outlet box with GFCI receptacle and the following features:

1. Cord: Type "SO" with (3) #12 AWG conductors.

2. Receptacle outlet: Single-gang FS outlet box with 20 amp, 125 volt, NEMA 5-20R GFCI type duplex receptacle, with weatherproof cover.

3. [Steel] [Cast aluminum] frame and steel reel sides.

4. Factory-assembled, modular type collector ring and brush block assembly.

5. Lifetime lubricated bearings.

6. Removable cover(s) for access to springs and ring/brush assembly.

7. Adjustable, four-roller cord outlet guide.

8. Built-in cord locking ratchet to hold cord at desired length. Ratchet can be disengaged to provide constant cord tension.

2.11 RETRACTABLE CORD REEL WITH FLOURESCENT HANDLAMP

A. Description: Factory-fabricated retractable cord reel with handlamp and the following features:

1. Cord: Type "SJOOW-A" cord with (3) #16 conductors, 300 volt rating.

2. Handlamp: Fluorescent handlamp with built in ballast and switch in handle.

3. Steel frame and steel reel sides.

4. Factory-assembled, modular type collector ring and brush block assembly.

5. Lifetime lubricated bearings.

6. Removable cover(s) for access to springs and ring/brush assembly.

7. Adjustable, four-roller cord outlet guide.

8. Built-in cable locking ratchet to hold cord at desired length. Ratchet can be disengaged when constant tension cable is desired.

9. Adjustable ball stop.

10. Three-foot lead in power cord with molded plug.

2.12 RETRACTABLE CORD REEL WITH EXPLOSION-PROOF FLUORESCENT HANDLAMP

A. Description: Factory-fabricated retractable cord reel with explosion-proof handlamp and the following features:

1. Cord: Type "SJOOW-A" cord with (3) #16 AWG conductors, 300 volt rating.

2. Handlamp: Explosion-proof fluorescent handlamp of an unswitched type that does not provide a means for plug-in of attachment plugs in accordance with NEC 511.4(B)(2).

3. Automatic switch inside reel shall turn on/off handlamp.

4. Steel frame and steel reel sides.

5. Factory-assembled, modular type collector ring and brush block assembly.

6. Lifetime lubricated bearings.

7. Removable cover(s) for access to springs and ring/brush assembly.

8. Adjustable, four-roller cord outlet guide.

9. Built-in cable locking ratchet to hold cord at desired length. Ratchet can be disengaged when constant tension cable is desired.

10. Adjustable ball stop.

11. Three-foot lead in power cord with molded plug.

2.13 RETRACTABLE CORD REEL WITH INCANDENSCENT HANDLAMP

A. Description: Factory-fabricated retractable cord reel with handlamp and the following features:

1. Cord: Type "SJOOW-A" cord with (3) #16 conductors, 300 volt rating.

2. Handlamp: Incandescent handlamp with switch in handle.

3. Steel frame and steel reel sides.

4. Factory-assembled, modular type collector ring and brush block assembly.

5. Lifetime lubricated bearings.

6. Removable cover(s) for access to springs and ring/brush assembly.

7. Adjustable, four-roller cord outlet guide.

8. Built-in cable locking ratchet to hold cord at desired length. Ratchet can be disengaged when constant tension cable is desired.

9. Adjustable ball stop.

10. Three-foot lead in power cord with molded plug.

2.14 RETRACTABLE CORD REEL WITH EXPLOSION-PROOF INCANDESCENT HANDLAMP

A. Description: Factory-fabricated retractable cord reel with explosion-proof handlamp and the following features:

1. Cord: Type "SJOOW-A" cord with (3) #16 AWG conductors, 300 volt rating.

2. Handlamp: Explosion-proof incandescent handlamp of an unswitched type that does not provide a means for plug-in of attachment plugs in accordance with NEC 511.4(B)(2).

3. Automatic switch inside reel shall turn on/off handlamp.

4. Steel frame and steel reel sides.

5. Factory-assembled, modular type collector ring and brush block assembly.

6. Lifetime lubricated bearings.

7. Removable cover(s) for access to springs and ring/brush assembly.

8. Adjustable, four-roller cord outlet guide.

9. Built-in cable locking ratchet to hold cord at desired length. Ratchet can be disengaged when constant tension cable is desired.

10. Adjustable ball stop.

11. Three-foot lead in power cord with molded plug.

2.15 FLOOR SERVICE FI f 1 INGS

A. Type: Modular, flush-type, dual-service units suitable for wiring method used.

B. Compartmentation: Barrier separates power and signal compartments.

C. Housing Material: Die-cast aluminum, satin finished.

D. Power Receptacle: NEMA WD 6, Configuration 5-20R, gray finish, unless otherwise indicated.

E. Signal Outlet: As shown on drawings.

2.16 POKE-THROUGH ASSEMBLIES

A. Description: Factory-fabricated and -wired assembly of below-floor junction box unit with multi-channeled, through-floor raceway/firestop unit and detachable matching floor service-outlet assembly.

1. Size: Selected to fit nominal 3-inch (75-mm) cored holes in floor and matched to floor thickness.
2. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
3. Closure Plug: Arranged to close unused 3-inch (75-mm) cored openings and reestablish fire rating of floor.
4. Wiring: Three No. 12 AWG power and ground conductors; one 75-ohm coaxial telephone/data cable; and one four-pair, 75-ohm telephone/data cable.

2.17 POKE-THROUGH FLOOR OUTLET

A. Computer/Data poke-through floor outlet shall be as follows:

1. Two-inch through-floor service fitting suitable for slab thickness installed.

2. UL classified for fire-rated floors.

3. UL listed for seven (7) No. 12 power and one (1) 25 pair No. 22 TSP data cables.

4. Provide insert barrier, service head barrier, suitable faceplates for devices, junction boxes, connectors, raceways, wiring devices as indicated on the drawings.

5. Provide carpet flanges or other type of finish to match the floor finish.

6. Poke-through shall be Raceway Components, Inc., Model NO. FIT-200-PF-.75/.75.

B. Telephone/Power Poke-Through Outlet shall be as follows:

1. Two-inch through-floor service fitting suitable for slab thickness installed.

2. UL classified for fire-rated floors.

3. UL listed for seven (7) No. 12 power and one (1) 25 pair No. 22 TSP data cables.

4. Provide insert barrier, service head barrier, suitable faceplates for devices, junction boxes, connectors, raceways, wiring devices as indicated on the drawings.

5. Two (2) receptacles and two (2) telephones (4 grommets).

6. Poke-through shall be Raceway Components, Inc., Model No. FIT-241-2R/2T.

2.18 FLOOR-MOUNTED DEVICES (INDIVIDUAL)

A. Individual, floor-mounted power, microphone, telephone, data, CATV, etc., outlets per plans. For multiple floor devices, combine outlets or jacks in common divided box with single, multi-gang coverplate.

B. General:

1. Flush-mounted, rectangular boxes: 1, 2, or 3 gang.

2. Carpet trim ring for devices in carpeted areas. Provide carpet insert.

3. For tiles, wood, or other hard floors, provide flush trim and coverplates, with no projections above the floor surface.

4. Single or multi-gang coverplates as required.

C. Construction:

1. Cast iron boxes, 3-5/16-inches deep.

2. 1, 2, or 3 divided compartments.

3. Fully adjustable prior to concrete pour.

4. Walker Omnibox 880CS Series, or equal.

D. Activation Kits:

1. Textured polycarbonate adjusting trim and cover plates.

2. Microphone outlets on stage:

a. Completely flush with no raised edges.

b. Brass cover with duplex flip-lid type covers.

c. Walker #828PR.

E. Receptacles, jacks and connectors: Provide receptacles, data, telephone, CATV and other connectors and wiring as specified elsewhere.

2.19 MULTI-SERVICE FLOOR BOXES:

A. Complete in-floor multi-service box consisting of floor box housing, flush removable cover, and wiring devices, as specified, all fittings, materials and labor.

B. Make adjustments in leveling and placement during rough-in to accommodate structural and architectural elements, and other equipment. Coordinate exact locations with Owner prior to concrete pour.

C. Construction:

1. Cast iron for on-grade applications and formed steel at all above grade levels unless otherwise noted on the Drawings.

2. Galvanized steel per ASTM 525 G-60.

3. Concrete-tight for in-floor use.

4. Adjustable legs for leveling and adjustment prior to pour.

5. Knockouts for conduit entry and feed-through use.

6. [Two (2)] Four (4) wiring compartments, individually sectionalized.

a. [One (1)]Two (2) duplex 5-20R power receptacles.

b. [One (1)] Two (2) duplex data RJ45 jacks, Category6.

7. UL listed, with separation of power and low voltage.

8. Hinged, completely flush cover with cable ports. Lid to have provisions for carpet insert (Walker #RAKMII option).

D. Walkerbox Resource RFB Multi-Service steel recessed floor boxes, or approved equal, by American Electric or Hubbell.

2.20 EMERGENCY PUSHBUTTONS

A. General:

1. Emergency pushbuttons shall be Stopper Station with Bopper Stopper cover, as manufactured by Safety Technology International, Inc. (STI), or approved equal.

B. Features:

1. Button activation shall be Push-to-Activate, Turn-to-Reset.

2. Interchangeable or replaceable Normally Open (N.O.) or Normally Closed (N.C.), Single-Pole, Single-Throw (SPST) gold-plated contact blocks rated for

three (3) amps at 600 VAC or one (1) amp at 250VDC.

3. Standard switch shall include one N.O. and one N.C. contact.

4. Switch shall hold up to three (3) sets of isolated contacts.

C. Construction:

1. Housing shall be molded of polycarbonate rated for temperature range of-40 degrees to 250 degrees Fahrenheit.

2. Housing color shall be yellow, unless otherwise indicated.

3. Pushbutton shall be provided with stainless steel backplate and matching polycarbonate spacer (as required), both having a 5VA flammability rating.

D. Labeling:

Designer Note: Select only the pushbutton types that apply to this project.

1. Pushbuttons shall be provided with a vinyl label that is customized to suit each application, including, but not limited to the following:

a. ["Emergency Power Off
b. ["Water Heating Shut-Down"]
c. ["Boiler Shut-Down"]
d. ["Emergency Utilities Off" (used when shutting off multiple utilities, i.e. power, air, water, and/or gas)]

E. Cover

1. Pushbutton covers shall have the following features:

a. Molded from thick clear polycarbonate material.
b. UV stabilized.
c. 94V-2 flammability rating.
d. Stainless steel torsion spring to maintain cover in a closed position.
e. Mounting hardware and gasket.

F. Quality Assurance

1. Pushbuttons shall be tested and approved or listed by:

a. Underwriter Laboratories (UL) and Canadian Underwriter Laboratories No. S7255.
b. Complies with UL 2017.
c. UL listed for indoor and outdoor use, when used with appropriate weather cover.

2. Pushbuttons shall be ADA Compliant.

G. Warranty

1. Pushbuttons shall be provided with lifetime guarantee against breakage of polycarbonate in normal use.
2. Pushbuttons shall be provided with one year guarantee on electro-mechanical and electronic components.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verification of existing conditions before starting work.

B. Verification of Conditions: Verify that field measurements, surfaces, substrates and conditions are as required, and ready to receive Work.

1. Verify that outlet boxes are installed at proper height.

2. Verify that wall openings are neatly cut and will be completely covered by wall plates.

3. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

C. By beginning Work, accepts conditions and assume responsibility for correcting unsuitable conditions encountered at no additional cost to the Owner.

3.2 INSTALLATION

A. Install devices and assemblies plumb, level, and secure.

B. Install wall plates when painting is complete.

C. Install wall dimmers to achieve indicated rating after derating for ganging as instructed by manufacturer.

D. Do not share neutral conductor on load side of dimmers.

E. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and grounding terminal of receptacles on top or as required by the local Authority Having Jurisdiction. Exception: Mount exterior GFI weatherproof duplex receptacles horizontally with grounding terminals on the left, or as required by the local Authority Having Jurisdiction. Group adjacent switches under single, multi-gang wall plates.

F. Protect devices and assemblies during painting.

G. Adjust locations at which floor service outlets and telephone/power service poles are installed to suit arrangement of partitions and furnishings.

H. Coordinate cord and plug connected equipment for type and ratings required.

I. Emergency shut-down toggle switches for boilers shall be provided at all means of egress from rooms in which boilers are installed. Boiler shut-down switches shall be clearly identified and shall be equipped with illuminated red toggle.

J. Receptacles on emergency circuits shall be clearly identified, with a circuit label indicating panelboard and circuit number.

K. Isolated ground receptacles shall be clearly identified.

L. All exterior receptacles and receptacles installed in wet or damp locations shall be ground fault circuit interrupter (GFCI) type and weatherproof.

M. All receptacles installed within six (6) feet of sinks, plumbing fixtures, and water pipes shall be ground fault circuit interrupter (GFCI) type.

N. Switches shall be located as indicated on the drawings, arranged singular or in gangs within 18" of the door jam on the strike side of the door openings. Verify the door swings with the Architectural Drawings prior to rough-in.

0. Install life safety system switches separate from the normal power switches. Do not include in the multiple gang configuration.

P. Switch and receptacle combinations shall be as above in a 2-gang box where both are of the same voltage. Provide separate boxes where different voltages are present.

Q. All switches in Mechanical Rooms, Electrical Rooms, **[attic space]** and other such places shall be a lighted handle, single-pole light switch(es) as required.

R. Install receptacles with ground pole in position **[top] [bottom]** as required by local authority having jurisdiction.

3.3 IDENTIFICATION

A. Comply with Division 16 Section, *Electrical Identification.*

1. Switches: Where three or more switches are ganged, and elsewhere as indicated, identify each switch with approved legend engraved on wall plate. Light switches shall be labeled as to lights controlled and with circuit number and panel identification.

2. Receptacles: Identify panelboard and circuit number from which served. Use machine-printed, pressure-sensitive, abrasion-resistant label tape on face of plate and durable wire markers or tags within outlet boxes. Protect label from damage during construction. Replace all damaged and unclear labels.

3. Mark all conductors with the panel and circuit number serving the device at the device.

4. Mark the panel and circuit number serving the device on the back side of the device plate with a permanent marking system, machine-generated, that does not show through the front of the plate.

3.4 CONNECTIONS

A. Connect wiring device grounding terminal to outlet box with bonding jumper.

B. Connect wiring device grounding terminal to branch-circuit equipment grounding conductor.

C. Isolated-Ground Receptacles: Connect to isolated-ground conductor routed to designated isolated equipment ground terminal of electrical system.

D. Tighten electrical connectors and terminals according to manufacturers published torque-tightening values. If manufacturers torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

A. Test wiring devices for proper polarity, continuity, short circuits, and ground continuity. Operate each device at least six times.

B. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.

C. Replace damaged or defective components.

3.6 CLEANING

A. Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION 262726

SECTION 262728 - DISCONNECT SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes individually mounted switches and circuit breakers used for the following:

1. Service disconnect switches.

2. Feeder and equipment disconnect switches.

3. Feeder branch-circuit protection.

4. Motor disconnect switches.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 26 Section, *Wiring Devices* for attachment plugs and receptacles, and snap switches used for disconnect switches.

2. Division 26 Section, *Switchboards* for individually enclosed, fused power-circuit devices used as feeder disconnect switches.

3. Division 26 Section, *Fuses* for fuses in fusible disconnect switches.

C. Provide method of disconnection at all appliances, motors, equipment, etc., as required to comply with NEC (including Article 422-C, and Article 440-D).

1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data for disconnect [switches," [circuit breakers,' and accessories specified in this Section.

C. Product Data for [switches,' [circuit breakers,] and accessories specified in this Section. Include the following:

1. Descriptive data and time-current curves.

2. Let-through current curves for circuit breakers with current-limiting characteristics.

D. Coordination charts and tables and related data.

E. Wiring diagrams detailing wiring for power and control systems and differentiating between manufacturer-installed and field-installed wiring.

F. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

G. Field test reports indicating and interpreting test results.

H. Maintenance data for tripping devices to include in the operation and maintenance manual specified in Division 1.

I. Submit a schedule of equipment to indicate ratings of disconnects, fuses, circuit breakers, and other electrical characteristics for each item of equipment.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: In addition to the requirements specified in Division 1 Section, *Quality Control*, an independent testing agency shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or shall be a full member company of the International Electrical Testing Association (NETA).

1. Testing Agency's Field Supervisor: Person currently certified by NETA or the National Institute for Certification in Engineering Technologies, to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain disconnect switches and circuit breakers from one source and by a single manufacturer.

C. Comply with NFPA 70 for components and installation.

D. Listing and Labeling: Provide disconnect switches and circuit breakers specified in this Section that are listed and labeled.

1. The Terms *Listed* and *Labeled:* As defined in the National Electrical Code, Article 100.

2. Listing and Labeling Agency Qualifications: A *Nationally Recognized Testing Laboratory* (NRTL) as defined in OSHA Regulation 1910.7.

3. Underwriters Laboratories (UL) listed equipment: UL 98 - Enclosed and Dead

Front Switches, UL 50 - Cabinets and Boxes, UL489 - Molded Case Circuit Breakers and Circuit Breaker Enclosures, NEMA 250 - Enclosures for Electrical Equipment.

4. Comply with ANSI and NEMA Standards for materials ratings.

5. Replacement circuit breakers shall be obtained from the original manufacturer through an authorized factory distribution complete with full factory warranty. Original manufacturer product data shall be submitted for review.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide equipment from one of the following manufacturers; no other manufacturers are acceptable.

1. Disconnect/Safety Switches:

   a. Square D Company. (Basis of Design)

   b. Eaton Corp.; Cutler-Hammer.

   c. Siemens Energy & Automation, Inc.

2. Molded-Case Circuit Breakers:

   a. Square D Company. (Basis of Design)

   b. Eaton Corporation; Cutler-Hammer.

   c. Siemens Energy & Automation, Inc.

3. Combination Circuit Breaker and Ground Fault Trip:

   a. Square D Company. (Basis of Design)

   b. Eaton Corporation, Cutler-Hammer.

   c. Siemens Energy & Automation, Inc.

4. Molded-Case, Current-Limiting Circuit Breakers:

   a. Square D Company. (Basis of Design)

   b. Eaton Corporation, Cutler-Hammer.

   c. Siemens Energy & Automation, Inc.

5. Integrally Fused, Molded-Case Circuit Breakers:

    a. Square D Company (Basis of Design)

    b. Eaton Corporation, Cutler-Hammer.

    c. Siemens Energy & Automation, Inc.

2.2 DISCONNECT SWITCHES

A. Enclosed, Nonfusible Switch: Heavy duty, NEMA KS 1, Type HD, with lockable handle in the *OFF* position. Switch shall be provided with an override screw to permit opening front cover with switch in *ON position.* Minimum fault current rating shall be 200,000 symmetrical rms amperes.

B. Enclosed, Fusible Switch, 800 A and Smaller: Heavy duty, NEMA KS 1, Type RD, clips to accommodate specified fuses, enclosure consistent with environment where located, handle lockable in the *OFF* position, with 2 padlocks, and interlocked with cover in CLOSED position. Switch shall be provided with an override screw to permit opening front cover with switch in *ON* position. Minimum fault current rating shall be 200,000 symmetrical rms amperes.

C. Characteristics: Size, number of poles and ratings as indicated and to match load being served.

D. Enclosure: NEMA KS I, Type 1, with gray baked enamel finish, unless otherwise specified or required to meet environmental conditions of installed location. Enclosure shall be rated for 200,000 rms symmetrical amperes short circuit current.

    1. Outdoor Locations: Type 4X, stainless steel, attached by molded hinges and Type 316 stainless steel hinge pins.

    2. Other Wet or Damp Indoor Locations: Type 4.

    4. Hazardous Areas Indicated on Drawings: Type 7C.

2.3 ENCLOSED CIRCUIT BREAKERS

A. Enclosed, Molded-Case Circuit Breaker: NEMA AB 1, with lockable handle.

B. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting rating to meet available fault current, minimum of 10,000 symmetrical rms amperes.

C. Application Listing: Appropriate for application, including switching fluorescent lighting loads or heating, air-conditioning, and refrigerating equipment.

D. Circuit Breakers, 200 A and Larger: Trip units interchangeable within frame size.

E. Circuit Breakers, 400 A and Larger: Field-adjustable, short-time and continuous-current settings.

F. Current-Limiting Trips: Where indicated, let-through ratings less than NEMA FU 1, Class RK-5.

G. Current Limiters: Where indicated, integral fuse listed for circuit breaker.

H. Molded-Case Switch: Where indicated, molded-case circuit breaker without trip units.

I. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.

J. Shunt Trip: Where indicated. Provide voltage rating as required.

K. Accessories: As indicated.

L. Enclosure: NEMA AB 1, Type 1, unless otherwise specified or required to meet environmental conditions of installed location.

1. Outdoor Locations: Type 4X, stainless steel.
2. Other Wet or Damp Indoor Locations: Type 4.
3. Hazardous Areas Indicated on Drawings: Type 7C.

M. Provide full capacity neutral lug [or 200 full capacity neutral for non-linear loads] and equipment grounding lug [and isolated ground lug where isolated grounding is indicated].

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install disconnect switches and circuit breakers in locations as indicated, according to manufacturer's written instructions.

B. Install disconnect switches and circuit breakers level and plumb. Provide mounting brackets, wall bracing, and accessories as required.

C. Install wiring between disconnect switches, circuit breakers, control, and indication devices.

D. Connect disconnect switches and circuit breakers and components to wiring system and to ground as indicated and instructed by manufacturer.

Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

E. Identify each [disconnect switch] [and circuit breaker] according to requirements

specified in Division 26 Section, *Electrical Identification.* All switches shall be provided with laminated plastic labels which clearly identify the equipment served.

1. Each disconnect means shall be legibly marked as required by Code (including all disconnect units for motors, appliances, feeders, and branch(es).

F. Provide fuses for all fusible safety switches as indicated and required by the load being served. Coordinate fusing of disconnects with mechanical equipment electrical characteristics.

G. Provide [disconnect switches] for all equipment as indicated and as required by the NEC. Where [disconnect switches] are specified and furnished with mechanical equipment, install one only. Coordinate devices furnished for mechanical equipment with Division 23 Drawings and Specifications.

H. Weatherproof switches shall be provided for all locations exposed to the elements whether called for or not.

I. Switches and unit circuit breakers shall be labeled for service entrance use, if so required, where used for service entrance whether called for or not.

J. Switches and unit circuit breaker provided shall be suitable for:

1. Circuit application voltage.
2. Circuit application ampacity x 125 percent.
3. One pole, two pole, three pole, solid neutral, ground connection, all as required by item served or as shown on the drawings.

K. Install circuit and motor disconnect switches and unit circuit breakers as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's *Standard of Installation,* and in accordance with recognized industry practices.

3.2 FIELD QUALITY CONTROL

A. Testing: After installing disconnect switches and breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.5 for disconnect switches and Section 7.6 for molded-case circuit breakers.
2. Certify compliance with test parameters.

B. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

3.3 ADJUSTING

A. Set field-adjustable disconnect switches and circuit-breaker trip ranges as

indicated.

3.4 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, and abrasions.

END OF SECTION 262728

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Fuses.

2. Spare Fuse Cabinet.

B. The electrical contractor shall provide a complete set of fuses for all fusible equipment on the project as indicated on the Contract Documents. Final test and inspections shall be made prior to energizing the equipment.

1.3 PERFORMANCE REQUIREMENTS

A. Select fuses to provide appropriate levels of short circuit and overcurrent protection for components such as wire, cable, bus structures, and other equipment. Provide system to ensure that component damage is within acceptable levels during a fault.

B. Select fuses to coordinate with time-current characteristics of other overcurrent protective elements, such as other fuses, circuit breakers, and protective relays. Provide system to ensure that device closest to fault operates.

1.4 SUBMISSIONS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data for each fuse type specified. Include the following:

1. Descriptive data and time-current curves.

2. Let-through current curves for fuses with current-limiting characteristics

3. Coordination charts and tables and related data.

4. Fuse size for elevator feeder and disconnect applications.

C. Field test reports indicating and interpreting test results.

D. Maintenance data for tripping devices to include in the operation and maintenance

manual [specified in Division 1].

E. Record the equipment nameplate rating and actual fuse rating and location of fuses on the record drawings.

F. Provide a complete short circuit coordination study report as required to select fuses to protect equipment.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses from one source and by a single manufacturer.

B. Comply with NFPA 70 for components and installation.

C. Listing and Labeling: Provide fuses specified in this Section that are listed and labeled.

1. The terms *Listed* and *Labeled* as defined in the National Electrical Code, Article 100.

2. Listing and Labeling Agency Qualifications: A *Nationally Recognized Testing Laboratory* (NRTL) as defined in OSHA Regulation 1910.7.

3. Comply with National Electrical Manufacturer's Association NEMA FU-1 *Low Voltage Cartridge Fuses.*

4. Comply with IEC269.

5. Comply with CANENA Standard 248.

6. Comply with UL 198.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. Spare Fuses: Furnish quantity equal to 20 percent of each 600 ampere and smaller fuse type and size installed, but not less than one (1) set of three (3) of each type and size. (Provide three (3) of each 601 Ampere and larger fuse type and size installed.)

2. Fuse Pullers: Furnish two (2) fuse pullers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering fuses that may be incorporated into the Work include, but are not limited to,

the following:

1. Cooper Industries Inc. Bussmann Div.

2. Eagle Electric Mfg, Co. Inc.

3. Ferraz Corp.

4. General Electric Co; Wiring Devices Div.

5. Gould Shawmut.

6. Tracor, Inc; Littelfuse, Inc. Subsidiary

B. All fuses shall be of the same manufacturer to assure coordination.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU-1, nonrenewable cartridge fuse; class as specified or indicated; current rating as indicated; voltage rating consistent with circuit voltage.

2.3 SPARE FUSE CABINET

A. Cabinet: Wall mounted, 0.05 inch (1.27) mm thick steel unit with full length, recessed piano-hinged door with key coded cam lock and pull, and circuit voltage.

1. Size: Adequate for orderly storage of spare fuses specified with 15 percent spare capacity minimum.

2. Size: Adequate for orderly storage of spare fuses specified with 15 percent spare capacity minimum.

3. Finish: Gray, baked enamel.

4. Identification: Stencil legend *SPARE FUSES* in 1-1/2-inch (40-mm) letters on door.

5. Fuse Pullers: For each size fuse.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine utilization equipment nameplates and installation instructions to verify proper fuse locations, sizes, and characteristics.

B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Main Service: Class L, fast acting, 600 Volt, 601-6000 Amp, and 300 kA interrupting rating.

B. Main Feeders: Class J, time delay, 600VoIt, 0-600 Amp, and 300 kA interrupting rating.

C. Motor Branch Circuits: Class RK1, time delay, 250 Volt Class J Time Delay 600 Volt, 0-600 Amp, and 300 kA interrupting rating. Time delay fuses shall hold 500% of rated current for a minimum of 10 seconds.

D. Other Branch Circuits: Class RK1, non-time delay, 250 Volt, Class J Time Delay 600 Volt, 0-600 Amp, and 300 kA interrupting rating.

E. Provide fuses of type and rating recommended by equipment manufacturer for packaged and/or specialized equipment.

F. Motor, transformer, feeder, and main service protection - 250 Volts or less:

1. Six hundred (600) ampere and less in interrupter switches, Class RK1, dual elements, time delay, 300 kA interrupting rating.
2. Four hundred (400) to six hundred (600) ampere in bolted pressure switches, Class J, 300 kA interrupting rating.

G. Motor, transformer, feeder, and main service protection - 600 volts or less; 600 ampere and less - Class RK-1, dual element, time delay, 300 kA interrupting rating.

H. Six hundred (600) ampere to six thousand (6000) ampere fuses used for protection of services, mains and feeders, Class L, current-limiting, time delay, 300 kA interrupting rating, rms symmetrical. Fuses shall be time delay and shall hold 500 percent of rated current for a minimum of four (4) seconds, clear 20 times rated current in 0.01 second or less, UL listed.

I. Six hundred ampere or less, installed ahead of breaker: Class RK1, time delay.

J. Six hundred ampere or less, for general power circuits: Class J, time-delay, dual element, 300 kA interrupting rating. Time-delay fuses shall hold 500 percent of rated current for a minimum of 10 seconds and shall be UL listed.

K. Fuse sizes for motor protection shall be chosen from fuse manufacturers published data and recommendations.

L. Control circuits and lighting: Class CC, current limiting rejection type, rated 0-30 amperes, 600 volts, and 200- kA interrupting rating.

M. Motor Circuits: All individual motor circuits with full-load ampere ratings (FLA) of 480 amperes or less shall be protected by Dual-Element Time-Delay Fuses. The following guidelines apply for motors protected by properly sized overload relays: Fuses for motors with a marked service factor not less than 1.15 shall be installed in ratings of 125% of motor full-load current (or next size larger if 125 percent does not correspond to a fuse

size), except where high ambient temperatures prevail, or where the motor drives a heavy revolving part which cannot be brought up to full speed quickly, such as large fans. Under such conditions, the fuses may be 150 percent to 175 percent of the motor full-load current. For all other motors, (such as 1.0 service factor motors) fuses shall be sized in ratings of 1 15 percent of the motor full load current (or next size larger if 115 percent does not correspond to a fuse size) except as noted above. The following guidelines apply where fuses are used as the only overload protection for the motor:

1. For motors with a 1.15 service factor or more, fuses should be sized at 125 percent of motor full-load current (or next size smaller if 125 percent does not correspond to a fuse size).
2. For all other motors, fuses should be sized at 115 percent of motor full-load current (or next size smaller, if 115 percent does not correspond to a fuse size.

N. Motor Controllers: NEMA and IEC Style motor controllers shall be protected from short-circuits by Dual-Element Time-Delay fuses in order to provide testing agency-witnessed Type 2 coordination for the controller. This provides *no damage* protection for the controller, under low and high level fault conditions, as required by IEC Publication 947-4. For IEC style controller, the fuses shall be installed in ratings to coordinate with the overload relays, such that the relay/fuse curves cross over at 7-10 times the IEC contactor current rating.

0. Switchboards, Panelboards, and Load Centers: The manufacturer shall supply equipment utilizing fully-rated and listed components. This equipment shall be tested, listed, and labeled for the available short-circuit current.

3.3 INSTALLATION

A. Fuses shall not be installed until equipment is ready to be energized. This measure prevents fuse damage during shipment of the equipment from the manufacturer to the job site, or from water that may contact the fuse before the equipment is installed. Final tests and inspections shall be made prior to energizing the equipment. This shall include a thorough cleaning, tightening, and review of all electrical connections and inspection of all grounding conductors. All fuses shall be furnished and installed by the electrical contractor. All fuses shall be of the same manufacturer.

B. Install fuses in fusible devices as indicated. Arrange fuses so fuse ratings are readable without removing fuse.

C. Install spare fuse cabinet where indicated.

D. Provide fuse clips as required.

3.4 IDENTIFICATION

A. Install typewritten labels on inside door of each fused switch to indicate fuse replacement information.

END OF SECTION 262813

SECTION 262913 – MOTOR CONTROLLERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes ac motor-control devices rated 600 V and less that are supplied as enclosed units.

B. Related Sections include the following:

1. Division 16 Section, *General Electrical Requirements* for Mechanical - Electrical coordination requirements.

2. Division 16 Section, *Basic Electrical Materials and Methods* for general materials and installation methods.

3. Division 16 Section, *Electrical Identification* for labeling materials.

4. Division 16 Section, Fu*ses.*

1.3 SUBMITTALS

A. Product Data: For products specified in this Section. Include dimensions, ratings, and data on features and components.

B. Maintenance Data: For products to include in the maintenance manuals specified in Division 1.

C. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

D. Submit a schedule of equipment to indicate motor controller ratings, sizes, and other electrical characteristics for each item of equipment.

E. Load Current and Overload Relay Heater List: Compiled and submitted by Contractor. Arrange to demonstrate selection of heaters to suit actual motor nameplate full load currents.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain, within 50 miles (80 km) of Project site, a service
center capable of providing training, parts, and emergency maintenance and repairs.

B. Source Limitations: Obtain similar motor-control devices through one source from a single manufacturer.

C. Comply with NFPA 70.

D. Listing and Labeling: Provide motor controllers specified in this Section that are listed and labeled.

1. The Terms *Listed* and *Labeled:* As defined in the National Electrical Code, Article 100.

2. Listing and Labeling Agency Qualifications: A *Nationally Recognized Testing Laboratory* as defined in OSHA Regulation 1910.7.

E. UL Compliance: NEMA ICS 2, *Industrial Control Devices, Controllers and Assemblies.*

1.5 COORDINATION

A. Coordinate features of controllers and accessory devices with pilot devices and control circuits to which they connect.

B. Coordinate features, accessories, and functions of each motor controller with the ratings and characteristics of the supply circuit, the motor, the required control sequence, and the duty cycle of the motor and load.

C. The horsepower rating of all starters shall be checked against actual motor to be controlled, before installation and correct size overload elements shall be provided in all starters based on nameplate and manufacturer's recommendation.

D. Provide all control devices and wiring, where not provided under Division 15, required for all equipment.

E. Motors and controllers shall be provided for voltage and current characteristics as indicated. In the event that equipment provided is of different electrical characteristics than the ones specified, any increase in electrical feeders, conduits, circuit breakers, etc., including increase of labor cost shall be the responsibility of the Contractor.

F. Provide branch circuits for all motors to the starting equipment and then to the motors, complete with all control wiring for automatic and remote control where required or noted. Conduits to motors shall terminate in the conduit fittings on the motors, the final connection being made with Liquid-tight Flexible Metal Conduit (LFMC), Seal-tight "UA", or approved equal.

G. All conduits and wiring required for control work from the holding coil circuit of the starter, including the furnishing and installation of control devices such as auxiliary

contacts, control relays, time delay relays, pilot lights, selector switches, alternators, etc., shall be provided and installed by other trades unless otherwise indicated.

H. Power Branch Circuits: Wire sizes for branch circuits not specifically called for on drawings or in Specifications shall be based on 125 percent of the full load current of the motor unless the voltage drop of motor branch circuits exceeds 1-1/2 percent from the distribution panel to the motor; in which case, voltage drop shall govern wire sizes. A power factor of 80 percent shall be used for motors in such calculations.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. Spare Fuses and Incandescent Indicating Lamps: Furnish 1 spare for every 5 installed units, but not less than 1 set of 3 of each type.

1.7 LEED REQUIREMENTS

A. Refer to Division 1 Section LEED Requirements for description of work under this Division affected by LEED requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
2. Allen-Bradley Company; Industrial Control Group.
3. Crouse-Hinds ECM.; Cooper Industries, Inc. Division.
4. Eaton Corporation; Westinghouse & Cutler-Hammer Products.
5. General Electric Company; Electrical Distribution & Control Division.
6. Siemens Energy & Automation, Inc. (Furnas Electric Division only).
7. Square D Company; Groupe Schneider.

B. All motor controllers shall be NEMA type controllers. IEC type controllers shall NOT be acceptable.

2.2 MANUAL CONTROLLER

A. Description: Manual controller switch, horsepower rated, double pole, single phase AC, brown toggle handle. Unit rating 30 Amp, 120-277 volt AC, no overload protection. Provide a handle locking guard device coverplate. Pass and Seymour No. 7812-PMD or approved equal.

2.3 MANUAL MOTOR STARTING SWITCHES

A. Description: NEMA ICS 2, general purpose, Class A with toggle action and melting alloy type overload element. Provide size and number of poles as required for a complete installation.

B. Thermal overload unit shall be interchangeable and starter shall be inoperative if thermal unit is removed. Units shall have built-in thermal overload protection properly sized for the equipment protected.

C. Toggle switch with pilot light shall be quick-make and quick-break type with self-indicating trip-free handle.

D. Enclosures shall be NEMA 1 for interior use and NEMA 4 stainless steel or cast iron for exterior, damp, or wet locations. Provide handle guard having locking provisions in the "OFF" position on all enclosures. Provide flush-mounted enclosures for units located in finished areas.

E. Starting switches shall be combined with a three-position hand-off-automatic selector switch and/or pilot indicating light mounted in the same enclosure.

F. Furnish Square D Company, Class 2510, or equivalent.

2.4 MAGNETIC MOTOR CONTROLLERS

A. Description: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, magnetic controller, unless otherwise indicated.

B. Control Circuit: Low voltage to be coordinated with Automatic Temperature Control Contractor; obtained from integral control power transformer. Include a control power transformer with adequate capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity. Integral transformer shall be provided with fused secondary protection.

C. Combination Controller: Factory-assembled combination controller and disconnect switch with or without overcurrent protection as indicated.

1. Circuit-Breaker Disconnect: NEMA AB 1, motor-circuit protector with field-adjustable short-circuit trip coordinated with motor locked-rotor amperes. Interlock with unit cover.

D. Overload Relay: Ambient-compensated type with inverse-time-current characteristic. Provide with heaters in each phase matched to nameplate full-load current of specific motor to which they connect.

E. Furnish Square D Company Class 8538 or equivalent.

F. Magnetic contactors for electric heating equipment or other equipment, as indicated, shall be as specified above, except without overload protection. Furnish Square D Company Class 8502 or equivalent.

G. Provide control H-O-A switches, red *running* and green *on* LED type pilot lights. Provide one normally open and one normally closed auxiliary control contacts in each starter in addition to the standard normally open sealing contact.

H. Minimum Size: NEMA Size 1.

2.5 ENCLOSURES

A. Description: All motor controllers shall be mounted in enclosures. Flush or surface-mounted cabinets as indicated. NEMA 250, *Enclosures for Electrical Equipment,* Type 1, unless otherwise indicated to meet environmental conditions at installed location.

I. Outdoor Locations: NEMA 250, Type 3R.

2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.

3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

2.6 REDUCED-VOLTAGE MOTOR CONTROLLERS

A. Solid-State Type: Suitable for use with standard NEMA Design B, 3-phase induction motors, providing adjustable acceleration rate control using voltage or current ramp. Provide adjustable starting torque control with up to 500 percent current limitation for 20 seconds. Provide surge suppressor in solid-state power circuits to provide 3-phase protection against damage form supply voltage surges 10 percent or more above nominal line voltage. Provide snubbers to prevent malfunction due to system voltage transients. Provide overload protection for NEMA Class 10 or better. Provide LED's to indicate motor and control status including control power available, controller on, overload trip, loss of phase, and shorted SCR.

B. Provide automatic voltage reduction controls to reduce voltage when motor is running at light load.

C. Provide a motor running contactor to operate automatically when full voltage is applied to the motor. Controller shall operate as a magnetic motor controller except during starting of motor.

2.7 ACCESSORIES

A. Devices are factory installed in controller enclosure, unless otherwise indicated.

B. Magnetic motor controllers shall be equipped with Push-Button Stations, Pilot Lights, and Hand-Off-Automatic Selector Switches: NEMA ICS 2, heavy-duty type. Provide red *running* and green *on* LED type pilot lights.

C. Stop and Lockout Push-Button Station: Momentary-break push-button station with a factory-applied hasp arranged so a padlock can be used to lock push button in depressed position with control circuit open.

D. Control Relays: Auxiliary and adjustable time-delay relays.

E. Auxiliary Control Contacts: Provide one normally open and one normally closed contacts in each starter in addition to the standard normally open sealing contact.

F. Pushbutton Stations, Pilot Lights, and Selector Switches: Heavy-duty type. All pushbutton stations and LED pilot lights shall be furnished and installed under the Electrical Division of the specifications and shall be provided with all wiring. Each individual pushbutton and LED pilot light shall be equipped with a legend plate. Legend plates with special markings shall be supplied by the manufacturer. Hand painted or otherwise marked in the field will not be acceptable. Pilot lights shall have LED lamps with clear lenses and operate on 120 volts. Pilot lights used in conjunction with magnetic starters shall be operated from auxiliary contacts in the start. Pilot lights connected to the start button or across the load side of starters will not be acceptable.

PART 3 EXECUTION

3.1 APPLICATIONS

A. Select features of each motor controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, drive, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Select horsepower rating of controllers to suit motor controlled.

C. Use fractional-horsepower manual controllers for single-phase motors, unless otherwise indicated.

D. Hand-Off-Automatic Selector Switches: In covers of manual and magnetic controllers of motors started and stopped by automatic controls or interlocks with other equipment.

E. Provide heaters and fuses correlated with full load nameplate current of motors provided. Set overload devices to suit motor provided.

3.2 INSTALLATION

A. Install independently mounted motor-control devices according to manufacturer's written instructions.

B. Manufacturer's Field Services: Provide services of a factory-authorized service

representative to supervise the field assembly and connection of components, including the pretesting and adjustment of solid-state controllers.

C. Location: Locate controllers within sight of motors controlled, unless otherwise indicated.

D. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks conforming to Division 16 Section, *Basic Electrical Materials and Methods.*

E. Install freestanding equipment on concrete housekeeping bases conforming to Division 3 Section, *Cast-in-Place Concrete.*

3.3 IDENTIFICATION

A. Identify motor-control components and control wiring according to Division 16 Section, *Electrical Identification.*

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between motor-control devices according to Division 16 Section, *Conductors and Cables.*

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic control devices where available.

3.5 CONNECTIONS

A. Tighten connectors, terminals, bus joints, and mountings. Tighten field-connected connectors and terminals, including screws and bolts, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.6 FIELD QUALITY CONTROL

A. Testing: After installing motor controllers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Sections 7.5, 7.6, and 7.16. Certify compliance with test parameters.

2. Remove and replace malfunctioning units with new units, and retest.

B. Reports: Prepare written reports certified by testing organization of tests and observations. Report defective materials and workmanship and unsatisfactory test results. Include records of repairs and adjustments made.

C. Labeling: On satisfactory completion of tests and related effort, apply a label to tested components indicating test results, date, and responsible organization and person.

D. Schedule visual and mechanical inspections and electrical tests with at least one week's advance notification.

E. Pretesting: On completing installation of the system, perform the following preparations for tests:

1. Make insulation resistance test of conducting parts of motor control components; and of connecting supply, feeder, and control circuits. For devices containing solid-state components, use test equipment and methods recommended by the manufacturer.

2. Make continuity tests of circuits.

3. Provide set of Contract Documents to test personnel. Include full updating on final system configuration and parameters where they supplement or differ from those indicated in the original Contract Documents.

4. Provide manufacturer's instructions for installation and testing of motor control devices to test personnel.

F. Visual and mechanical inspection: Include the following inspections and related work.

1. Motor-Control Device Ratings and Settings: Verify that ratings and settings as installed are appropriate for final loads and final system arrangement and parameters. Recommend final protective-device ratings and settings where differences are found. Use accepted revised ratings or settings to make the final system adjustments. Prepare and submit the load current and overload relay heater list.

2. Inspect for defects and physical damage, NRTL labeling, and nameplate compliance with current project drawings.

3. Exercise and perform operational tests of mechanical components and other operable devices in accordance with manufacturer's instructions.

4. Check tightness of electrical connections of devices with calibrated torque wrench. Use Manufacturer's recommended torque values.

5. Clean devices using Manufacturer's approved methods and materials.

6. Verify proper fuse types and ratings in fusible devices.

G. Electrical Tests: Perform the following in accordance with manufacturer's instructions:

1. Insulation resistance test of motor control devices conducting parts to the extent permitted by the manufacturer's instructions. Insulation resistance less than 100 megohms is not acceptable.

2. Use primary current injection to check performance characteristics of motor-circuit protectors and for overload relays of controllers for motors 15 horsepower and larger. Trip characteristics not within manufacturer's published time-current tolerances are not acceptable.
3. Make adjustments for final settings of adjustable-trip devices.

4. Test auxiliary protective features such as loss of phase, phase unbalance and undervoltage to verify operation.

5. Check for improper voltages at terminals in controllers that have external control wiring when controller disconnect is opened. Any voltage over 30V is unacceptable.

H. Correct deficiencies and retest motor control devices. Verify by the system tests that specified requirements are met.

3.7 CLEANING

A. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean devices internally, using methods and materials recommended by manufacturer.

3.8 DEMONSTRATION

A. Training: Engage a factory-authorized service representative to demonstrate solid-state and variable- speed controllers and train Owner's maintenance personnel.

1. Conduct a minimum of 4 hours of training in operation and maintenance as specified in Division 1 Section, *Contract Closeout.* Include training relating to equipment operation and maintenance procedures.

2. Schedule training with at least 7 days' advance notice.

END OF SECTION 262913

SECTION 264113 - LIGHTNING PROTECTION SYSTEM

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.

B. Refer to Division 26, Section, *Common Work Results for Electrical* for basic electrical installation requirements.

C. Refer to Division 26, Section *Surge Protection Devices* for Surge Protective Device (SPD) requirements.

D. Refer to Division 26, Section, *Grounding and Bonding.*

1.2 SUMMARY

A. This section includes lightning protection systems for buildings and associated structures and includes requirements for lightning protection system components complying with UL96, UL96A, and NFPA 780.

B. Contractor shall provide additional components and labor in order to meet all requirements of Master Labeled Lightning Protection System.

1.3 SYSTEM DESCRIPTION

A. Protect entire building, including roof projections, chimneys, and roof-mounted equipment.

B. Provide a complete UL Master Labeled Lightning Protection System.

C. Provide a complete all-inclusive Lightning Protection System Design layout and installation for a complete UL Master Labeled Lightning Protection System.

D. Design Requirements: Lightning Protection Conductor System consisting of air terminals on roofs, roof-mounted mechanical equipment, parapets, bonding of structure and other metal objects, grounding electrodes, and interconnecting conductors.

E. Provide an all-inclusive Lightning Protection System. The Contract Drawings and Specifications do not necessarily limit the extent of the system that is required to meet the requirements and the intent of the Engineer and the Contract Documents for a complete system.

1.4 SUBMITTALS

A. General: Submit the following according to Conditions of Contract and Division 1 Specification Sections.

B. Product data for each component: Include data for roof adhesive when used. Submit accurate pictorial views of decorative air terminal components. Provide dimensions and materials of each component and include indication of listing in accordance with UL 96. Provide scaled shop drawings detailing lightning protection system including, but not limited to, air terminal locations, grounding electrodes, conductor sizes and routing, bonding connections to structures, and connections and grounding. Include connection and termination details. The shop drawings shall be Master Labeled stamped. Submit a roof plan and a ground floor plan with all equipment properly dimensioned.

C. Qualification data for firms and persons specified in *Quality Assurance* Article to demonstrate their capabilities and experience. Include list of completed projects with project names, addresses, names of Architects and Owners, and other information specified.

D. Field inspection reports indicating compliance with specified requirements.

E. Project Record Documents - Accurately record the following: Actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors in project record documents.

F. Submit a UL compliance certificate indicating compliance with all requirements.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced and LPI-Certified Master Installer to install the Lightning Protection System. The installation shall be under the direct supervision of an LPI-Certified Master Installer.

B. Designer Qualifications: Engage an LPI-Certified Designer to design and lay out the Lightning Protection System.

C. Inspector Qualifications: Engage an LPI-Certified Inspector to perform periodic inspections during installation of the Lightning Protection System.

D. Manufacturers Qualifications: Provide products by firms listed and approved by Underwriters Laboratories, Inc., having had not less than five (5) years experience in this specialty work under UL procedures.

E. Listing and Labeling: Provide products specified in this Section that are listed and labeled by an organization concerned with product evaluations, and that can determine compliance with appropriate standards for the current production of listed items.

1. Listing and Labeling Agency Qualifications; A *Nationally Recognized Testing Laboratory* (NRTL) as defined in OSHA Regulation 1910.7.

F. Conform to NFPA 780, *Lightning Protection Code*.

G. Conform to UL 96, *Standard for Lightning Protection Components*.

H. Conform to UL 96A, *Installation Requirements for Lightning Protection Systems* and provide UL Master Label Certificate.

I. Conform to LPI-1 *7 5, Lightning Protection Installation Standard* and provide LPI-certified system.

J. Conform to NFPA 70, *National Electrical Code.*

K. Conform to the most stringent requirements when more than one standard is specified for products or installation.

1.6 WORKMANSHIP

A. Guarantee all materials and workmanship furnished and installed under this section of the specifications two years from the date of final acceptance of work. The Contractor also agrees that he will, at his own expense, repair and/or replace all such defective materials or effective workmanship which become defective during the term of this guarantee.

1.7 SEQUENCING AND SCHEDULING

A. Coordinate installation of lightning protection system with the installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection system, and building finishes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturer's offering lightning protection components that may be incorporated in the Work include but are not limited to, the following:

1. A-C Lightning Security, Inc.

2. Bonded Lightning Protection, Inc.

3. East Coast Lightning Equipment, Inc.

4. Harger Lightning Protection, Inc.

5. Heary Brothers Lightning Protection.

6. Independent Protection Company, Inc.

7. Robbins Lightning Protection, Inc.

8. Thompson Lightning Protection.

9. Warren Lightning Rod Company.

2.2 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. Lightning Protection System Products: Manufactured to NFPA 780, LPI-176, *Lightning Protection System Material and Components Standard,* and UL 96, *Lightning Protection Components.*

B. System Materials: Copper with solid air terminals.

C. Air Terminals for Roof Mounting: Units with bases especially designed for the specified roof materials. Solid copper, 1/2-inch in diameter with blunt nickel-plated points.

1. Air Terminal Bases: Cast bronze with bolt pressure cable connections and shall be securely mounted with stainless steel screws and bolts. Bases on modified bitumen roofs shall be secured with a proper adhesive.

2. For portions of the building under 75 feet in height, Class I materials may be used. Air terminals shall be 1/2-inch diameter copper extending a minimum of 24 inches above the protected object.

3. Wherever materials come in direct contact with aluminum surfaces on buildings over 75 feet in height, the air terminals shall be 5/8-inch diameter aluminum extending a minimum of 24 inches above the object they protect.

4. Wherever materials come in direct contact with aluminum surfaces on buildings under 75 feet in height, the air terminals shall be 1/2-inch diameter aluminum extending a minimum of 24 inches above the object they protect.

D. Ground Rods: Copper clad steel (10 mil finish) with a minimum of 7 percent of the rod weight in the copper cladding.

1. Diameter: 3/4 inch (19 mm).

2. Length: 10 feet (3 m).

E. Ground Plate: Solid copper, not less than 1/16th inch (2mm) thick.

F. Conductors:

1. Copper cable conductors: Class II - Twenty-eight strand copper.

a. Minimum 7/16-inch diameter.

b. Minimum 375 lbs. / 1000 LF.

c. Minimum #12 AWG conductors.

d. Minimum #1/0 AWG counterpoise.

e. For portions of the building under 75 feet in height, Class I materials may be used. The cable shall be 29 strands, 17 gauge per strand copper wire cable weighing 200 pounds per 1000 feet.

2. Aluminum cable conductors

a. Prohibited in contact with earth.

b. Prohibited where contributing to rapid corrosion.

c. Aluminum conductors for bonding or interconnecting metallic bodies to the main cable shall be #4 AWG aluminum wire in strength and cross section.

d. Perforated strips shall not be used.

e. In all areas where the cable comes in direct contact with aluminum material, aluminum cable must be used. For portions of the building over 75 feet in height, the aluminum cable should be 37 strands, 13 gauge per strand aluminum cable, weighing 190 pounds per 1000 feet. For portions of the building under 75 feet in height, the cable should be 24 strands, 14 gauge per strand aluminum cable, weighing 110 pounds per 1000 feet.

3. If the building has structural steel columns, the structural steel columns may be used as the down-conductors.

G. Connectors and Splices - Exothermic, conforming to UL 96.

H. Ground Test Well For accessible connection for testing. Ground test well shall be heavy duty 12-inch length (minimum) with cast iron lid and frame.

I. Roof Penetrations: Through-roof assemblies with solid bars and appropriate roof flashings.

J. Miscellaneous Components: Provide other components required for a complete lightning protection system such as bonding plates, terminal supports, clips, anchors, fasteners, bolts, nuts, screws, etc. All components shall conform to UL 96 for applicable classes.

1. Bonding plates shall not be less than 8 square inches of surface contact secured in place with stainless steel bolts.

K. Conduit: Provide 1-inch Type 40 PVC conduit for all down conductors. All conduit shall be concealed.

L. Waterproof Penetrations: The Contractor shall provide all waterproofing for the through-roof conduits, connectors, and other penetrations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Verify that field measurements, surfaces, substrates and conditions are as required, and ready to receive work.

B. Examine surfaces and conditions, with Installer present, for compliance with installation tolerances and other conditions affecting performance of the lightning protection system. Do not proceed with installation until unsatisfactory conditions have been corrected.

C. By beginning work, conditions are accepted with the responsibility for correcting unsuitable conditions encountered at no additional cost to the Owner.

D. Lightning Protection System shall be provided with UL Master Label Certificate. Turn UL Master Label Certificate over to the Owner upon system approval, and include one (1) copy of the same in the Operation and Maintenance Manual(s).

3.2 INSTALLATION

A. Install lightning protection systems as indicated, according to manufacturer's written instructions.

B. Install components according to LPI-175, UL 96A, and NFPA 780.

C. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops. Run conductors in nonmetallic raceway, Schedule 40, minimum.

D. Conceal system conductors. Support conductors every three (3) feet.

E. Conceal down conductors.

F. Conceal interior conductors.

G. Conceal conductors from normal view from exterior locations at grade within 200 feet (60 m) of building.

H. Notify Engineer at least 48 hours before concealing lightning protection system components.

I. Cable Connections: Use approved exothermic-welded connections for all conductor splices and connections between conductors and other components, except those above single-ply membrane roofing.

J. Air Terminals on Specified roofing: Use adhesive recommended by manufacturer of air terminals and approved by manufacturer of roofing material. Comply with adhesive manufacturer's installation instructions. Maximum spacing of 25 feet.

K. Bond extremities of vertical metal bodies exceeding 60 feet (18 m) in length to the

Lightning Protection System.

L. Bond ground terminals with counterpoise conductor located below grade.

M. Bond grounded media on building within 12 feet (4 m) of ground with counterpoise conductor located as indicated.

N. Bond grounded media on building within 1 foot (4m) of roof with counterpoise conductor.

0. Bond grounded media on building within 12 feet (4m) of roof with interconnecting loop at eave level or above.

P. Bond lightning protection system to grounded media on building at every 60 feet (18 m) with intermediate-level interconnection loop conductors.

Q. Install the conductors as inconspicuously as practical and with the proper bends. Install conductors avoiding radius bends of less than 8 inches.

R. Install the vertical conductors within the concealed cavity of exterior walls. Route the conductors to the exterior at elevations below the finished grade and make the ground connections to the earth outside of the building or stack perimeter.

S. Where shown, use the structural steel framework or reinforcing steel as the main conductor: Weld or bond the non-electrically-continuous sections together and make them electrically-continuous.

T. Protect copper conductors with stiff copper or brass tubing, which enclose the conductors from the top to the bottom of the tubing, between 300 mm (one foot) below and 2100 mm (seven feet) above the finished grade.

U. Sheath copper conductors, which pass over cast stone. Cut stone, architectural concrete, and masonry surfaces with not less than a 2 mm (1/16-inch) thickness of lead to prevent staining of the exterior finish surfaces.

3.3 AIR TERMINAL INSTALLATION

A. Install per UL and NFPA requirements:

1. Rigidly connect to structure.

2. Make electrically continuous with roof conductors by means of pressure connectors or crimped joints.

3. At ends of structures, set 24-inches from end of ridge or edges and corner of roof.

4. Maximum spacing of 20 feet.

5. Prevent overturning by means of tripod or braces.

6. Uniformly space air terminals about the rim of the stack, not more than 24 inches from the corners or more than 8'-0-inches apart.

7. Air terminals on standing seam metal roof systems shall be secured with aluminum clamps designed for standing seam metal roofing systems.

3.4 ROOF CONDUCTORS

A. Install per UL and NFPA requirements:

1. Connect directly to roof or ridge at 48-inch intervals.

2. Prevent sharp bends or turns.

3. Minimum bend radius of 8 inches.

4. Provide a downward or horizontal course.

5. All connections shall be electrically continuous.

6. Follow contours of flat roofs, ridges, parapets and edges.

3.5 DOWN CONDUCTORS

A. Installation:

1. Do not pass through non-conducting parts of structure.

2. Interconnect secondary conductors with grounded parts within the building.

B. Down Lead Conductors Run in Raceways: All down lead conductors shall be run in I – inch Type 40 PVC conduit. All raceways shall be concealed. Raceways shall be placed at opposite sides of the stack. Bends shall be kept to a minimum and where used shall have an angle not to exceed 90 degrees. Openings shall be free and clear. Contractor shall provide conduits at various locations in the outer walls as required.

C. Provide a minimum of two down conductors located as widely separated as possible, at diagonally opposite corners.

D. Down lead cables shall not be brought directly through the roof. Through-roof assemblies with solid rods shall be used for this purpose.

3.6 INTERCONNECTION OF METAL PARTS

A. Metal doors, windows and gutters shall be connected directly to the grounds or down conductors using minimum No. 6 copper conductor, or equivalent. Increase size or protect conductors where exposed to corrosion or physical damage. Ground connections to metal doors and windows shall be by mechanical ties under pressure, or equivalent.

B. Metal ventilators shall be rigidly connected to the roof conductor at three places on the

ventilator.

C. Metal bodies of conductance shall be protected if not within the zone of protection of the air terminals. All metal bodies having equal to, or greater than, 400 square inches shall be bonded to the lightning protection system using main size conductors and a bonding plate with not less than 3 square inches. Provisions shall be made to guard against corrosion due to joining of dissimilar metals. Provide air terminals on metals that are less than 3/16th-inch thick, which are not in the *cone of protection* on roof areas, such as ventilators, air conditioning units, etc., all as required by the stated Code.

D. All major rooftop mechanical equipment and isolated metal bodies within 6 feet of system conductors shall be bonded to lightning protections system's main roof conductor with secondary conductors and appropriate bonding devices. Do not penetrate airside housings for anchoring. Seal air and water tight all connections at mechanical equipment.

E. Interconnect conductive and inductive metals as required by the UL 96A Code.

3.7 GROUND CONNECTIONS

A. Use exothermic welding type connections which form solid metal joints in the main vertical and horizontal conductors, and for connections that are not exposed in the finish work.

B. Provide ground connection for each down conductor.

C. Metal water pipes and other large underground metallic objects shall be bonded together with all grounding mediums.

D. Ground connections shall be protected from mechanical injury.

E. In making ground connections, utilize permanently moist areas as applicable.

F. For the conductors located outside of the building, install the conductors not less than 2 feet (600 mm) below the finished grade.

G. Make connections of dissimilar metal with bi-metallic type fittings to prevent electrolytic action.

H. For structural steel buildings, connect the steel framework of the buildings to the main water pipe near the water system entrance to the building.

I. Connect exterior metal surfaces, located within three feet (900 mm) of the lightning protection system conductors, to the lightning protection system conductors to prevent flashovers.

J. Do not pierce the structural steel in any manner. Connections to the structural steel shall conform to the UL Publication No. 96A.

K. Install ground connections to earth at not more than 60 foot (1800 mm) intervals around

the perimeter of the building.

L. Weld or braze bonding plates, not less than eight inches (200 mm) square, to cleaned sections of the steel and connect the conductors to the plates.

M. Connections to Lightning Protection System: Bond grounding conductors, including grounding-conductor conduits, to lightning protection down conductors or lightning protection grounding conductors in compliance with NFPA 780.

N. Common Ground Bonding with Lightning Protection System: Bond electric power system ground directly to lightning protection system grounding conductor at closest point to electric service grounding electrode. Use bonding conductor sized same as system grounding conductor and install in conduit.

3.8 GROUNDING ELECTRODES

A. Provide for each down conductor.

B. Drive into earth minimum of 10 feet. Ground rods shall be not less than 2 feet, nor more than 10 feet from the structure.

C. Counterpoise shall be No. 1/0 copper cable and shall be laid around the perimeter of the structure in a trench.

D. Ground rods shall be installed such that the top is not less than 2 feet below finished grade.

E. Ground rod resistance shall not exceed 10 ohms. The resistance of the entire grounding system shall not exceed 5 ohms.

F. Provide test wells installed flush with the finished grade.

3.9 CORROSION PROTECTION

A. Use no combination of materials to form an electrolytic couple that will accelerate corrosion in the presence of moisture, unless moisture is permanently excluded from the junction of such materials.

B. Use conductors with suitable protective coatings where conditions would cause deterioration or corrosion of conductors.

3.10 FIELD QUALITY CONTROL

A. Periodic Inspection: Provide the services of a qualified inspector to perform periodic inspection according to LPI-177, *Inspection Guide for LPI Certified Systems.*

B. UL Inspection: Provide the services of Underwriters Laboratories, Inc. to perform inspections. Make revisions as required to obtain Master Label Certificate.

C. Certification: Two weeks prior to final inspection, deliver to the Owner four copies of the

Certification that the installed lightning protection system has been inspected by a UL representative and has been approved by UL without variation.

D. Prior to commencement of any work, the Contractor shall obtain and deliver to the Owner the application and inspection forms necessary to file application for the LPI Certified System Certificates. As applicable, these forms include: Stage 1 - Grounding Inspection Report; Stage 2 - Concealed Components Inspection Report; and Stage 3 - Final Inspection Report.

E. The Contractor shall perform required inspections at the appropriate times and upon completion of the job shall forward the above Inspection Report forms to the Lightning Protection Institute to obtain the LPI Certified System Certificate.

F. Verify the electrical continuity by measuring the ground resistance to earth at the ground level, at the top of the building or stack, and at intermediate points with a sensitive ohmmeter. Compare the resistance readings. Ground resistance shall not exceed 5 ohms. Submit test results.

3.11 CONNECTIONS TO EXISTING SYSTEM

A. Where the drawings show the new lightning protection system connected to an existing lightning protection system without a UL master label, the new portion of the lightning system still requires inspection and labels as specified above for new work.

END OF SECTION 264113

SECTION 264313 – SURGE PROTECTIVE DEVICES (SPDS) FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes field-mounted SPDs for low-voltage (<1000 V) power distribution and control equipment.

1.3 DEFINITIIONS

A. VPR: Voltage Protection Rating.

B. SPD: Surge Protection Device(s).

C. $I_{(N)}$: Nominal Discharge Current.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating weights, electrical characteristics, furnished specialties, and accessories.

B. Qualification Data: For qualified testing agency.

C. Product Certificates: For SPDs to from manufacturer.

D. Operation and Maintenance Data: For SPDs to include operation, and maintenance manuals.

E. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency, and marked for intended location and application.

B. The unit shall be UL 1449 3rd edition Listed and CUL Approved as a Surge Protective Device and UL 1283 listed as an Electromagnetic Interference Filter.

C. Comply with IEEE C62.41.2 and test devices according to IEEE C62.45.

D. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Service Conditions: Rate SPDs for continuous operation under the following conditions unless otherwise indicated:

1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage for 480/277Y and not less than 125 per-cent of nominal system operating voltage for 208/120Y.
2. Operating Temperature: 30 to 150 deg F (0 to 65 deg C).
3. Humidity: 0 to 95 percent, non-condensing.
4. Altitude: Less than 12,000 feet (3962 m) above sea level.

1.7 COORDINATION

A. Coordinate location of field-mounted SPDs to allow adequate clearances for maintenance.

B. Coordinate SPDs with Division 26 Section “Electrical Power Monitoring and Control”.

1.8 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of surge suppressors that fails in material or workmanship within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

1.9 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Replaceable Protection Modules: 1 of each size and type installed.

PART 2 - PRODUCTS

2.1 SERVICE ENTRANCE SUPPRESSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Schneider Electric/Square D Corporation; Surgelogic IMA Series Modular SPD mounted within the electrical gear or comparable product by one of the following:

1. Square D Surgelogic; a brand of Schneider Electric.

B. Surge Protective Devices shall be:

1. UL 1449 3rd edition Listed TYPE 2.
2. Modular design (with field-replaceable modules).
3. Fuses, rated at 200-kA interrupting capacity.
4. Minimum UL 1449 3rd edition withstand (I_n) rating to be 20kA per mode.
5. Bolted compression lugs for internal wiring.

6. Integral disconnecting means.
7. Redundant suppression circuits.
8. Replaceable modules, 1 per phase minimum.
9. LED indicator lights for power and protection status.
10. Audible alarm, with silencing switch, to indicate when protection has failed.
11. Form-C contacts rated at 2 A and 24-V ac minimum, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
12. Six-digit transient-event counter set to totalize transient surges.

C. Peak Single-Impulse Surge Current Ratings to be selected by environment:

Category/Type	Application	Per Phase	Per Mode
C Type 2	Service Entrance	240 kA	120 kA
B Type 2	High Exposure Locations (Distribution Equipment)	160 kA	80 kA

D. The ANSI/UL 1449 voltage protection rating (VPR) in grounded wye circuits, the SPDs shall not exceed the following:

Modes	208Y/120	480Y/277	600Y/347
L-N, L-G, N-G	800	1200	1500
L-L	1200	2000	2500

E. The ANSI/UL 1449 VPR for 240/120 V, 3-wire or 4-wire circuits with high leg shall not exceed the following:

Modes	240/120
L-N, L-G, N-G	1200/800

2.2 PANELBOARD SUPPRESSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Schneider Electric Corporation; Surgelogic IMA Modular Series within the electrical gear, or comparable product by one of the following:
1. Square D; a brand of Schneider Electric.

B. Surge Protective Devices:

1. UL 1449 3rd edition Listed TYPE 2.
2. Modular design.
3. Short-circuit current rating complying with UL 1449, and matching or exceeding the panelboard short-circuit rating and redundant suppression circuits; with fused metal-oxide varistors.
4. Fuses, rated at 200-kA interrupting capacity.
5. Minimum UL 1449 3rd edition withstand (I_n) rating to be 20kA per mode.
6. Fabrication using bolted compression lugs for internal wiring.
7. Replaceable modules.
8. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
9. LED indicator lights for power and protection status.
10. Audible alarm, with silencing switch, to indicate when protection has failed.
11. Form-C contacts rated at 2 A and 24-V ac minimum, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
12. Six-digit transient-event counter set to totalize transient surges.

C. Peak Single-Impulse Surge Current Rating:

Category/Type	Application	Per Phase	Per Mode
B Type 2	High Exposure Locations (Distribution Equipment)	160kA	80kA
B Type 2	Branch Locations	120kA	60kA

D. The ANI/UL 1449 voltage protection rating (VPR) in grounded wye circuits, the SPDs shall not exceed the following:

Modes	208Y/120	480Y/277	600Y/347
L-N, L-G, N-G	800	1200	1500
B Type 2	1200	2000	2500

E. The ANSI/UL 1449 VPR for 240/120 V, 3-wire or 4-wire circuits with high leg shall not exceed the following:

Modes	240/120
L-N, L-G, N-G	1200/800

2.3 ENCLOSURES (when not internally mounted into gear)

A. Indoor Enclosures: Not applicable.

B. Outdoor Enclosures: Not applicable.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install SPDs at service entrance on load side, with ground lead bonded to service entrance ground.

B. Install SPDs for panelboards and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

1. Provide 60 Amp circuit breaker as a dedicated disconnecting means for SPD unless otherwise indicated.

3.2 FIELD QUALITY CONTROL

A. Ensure that interiors are free of foreign materials and dirt.

B. Check and test switches, pushbuttons, meters for proper operation.

C. Check and test indicating lights for proper operation and color.

D. Perform manufacturers on site field test procedures.

3.3 STARTUP SERVICE

A. Do not perform insulation resistance (MEGGER) tests of the distribution wiring equipment with the SPDs installed. Disconnect all wires, including neutral, before conducting insulation resistance tests, and reconnect immediately after the testing is over.

END OF SECTION 264313

SECTION 265100 - INTERIOR LIGHTING

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 interior lighting fixtures, lamps, ballasts, emergency lighting units, and accessories.

B. Related Sections include the following: Division 16 Section, *Lighting Control Equipment* for programmable lighting control systems, time switches, additional photoelectric relays, power relays, and contactors.

C. Provide a lighting fixture for each fixture shown on the Drawings as described in this Specification, of the design and quality indicated herein. Provide fixtures complete, including lamps of the wattage and type indicated. Unless otherwise indicated on the Drawings or herein, all lighting fixtures, as a minimum, shall be the Manufacturer's specification grade type fixtures.

D. All materials, accessories, and any other equipment necessary for the complete and proper installation of all lighting fixtures included in this contract shall be furnished by the Contractor.

E. Conformance: Fixtures shall be manufactured in strict accordance with the Contract Drawings and Specifications.

F. Specifications and scale drawings are intended to convey the salient features, function and character of the fixtures only, and do not undertake to illustrate or set forth every item or detail necessary for the work.

G. Minor details, not usually indicated on the Drawings nor specified, but that are necessary for the proper execution and completion of the fixtures, shall be included, the same as if they were herein specified or indicated on the Drawings.

H. Omissions: The **[Architect] [Owner]** or **[Engineer]** shall not be held responsible for the omission or absence of any detail, construction feature, etc., which may be required in the production of the fixtures. The responsibility of accurately fabricating the fixtures to the fulfillment of this Specification rests with the Contractor.

1.3 SUBMITTALS

A. Product Data: Submit fixture shop drawings in booklet form with separate sheet for each type of lighting fixture indicated, arranged in order of fixture designation. Include data on features, accessories, and the following:

1. Dimensions of fixtures.

2. Certified results of independent laboratory test for fixtures and lamps for electrical ratings and photometric data. Test data shall include manufacturer and model number for fixture being submitted.

3. Emergency lighting unit battery and charger.

4. Fluorescent and high-intensity-discharge ballasts.

5. Types of lamps.

B. Shop Drawings: Show details of nonstandard or custom fixtures. Indicate dimensions, weights, method of field assembly, components, features, and accessories.

1. Wiring Diagrams: Detail wiring for fixtures and differentiate between manufacturer-installed and field-installed wiring.

C. [Coordination Drawings: Reflected ceiling plans and sections drawn to scale and coordinating fixture installation with ceiling grid, ceiling-mounted items and other components in the vicinity. Include work of all trades that is to be installed near lighting equipment.]

D. Samples for Verification: For lighting fixtures designated for sample submission in this Specification.

1. Lamps: Specified units installed.

2. Ballast: 120-V model of specified ballast type.

3. Accessories: Cord and plug.

E. Product Certificates: Signed by manufacturers of lighting fixtures certifying that products comply with requirements.

F. Dimming Ballast Compatibility Certificates: Signed by manufacturer of ballast certifying that ballasts are compatible with dimming systems and equipment with which they are used.

G. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

H. Record Documents: Accurately record actual location of each luminaire with the associated switching/control arrangement.

I. Maintenance Data: For lighting fixtures to include in maintenance manuals specified in Division I. Include technical data sheets and parts ordering information. Include testing and maintenance requirements and instructions for emergency lighting equipment.

J. Lighting Calculations: Submit point-by-point lighting calculations for fixture types noted in this Specification. All calculations shall strictly conform to IES Standards.

K. Samples: Provide samples for verification purposes of specific individual fixtures as indicated in this Specification. Refer to paragraph "Samples", in this Section, for additional information.

1.4 SAMPLES

A. After shop drawing review and prior to release for manufacturing, the Contractor shall furnish one sample of each fixture in this Specification for which sample requirement is noted.

B. Shipping: The samples shall be complete with specified lamps and compatible ballast, ready for hanging, energizing, and examining, and shall be shipped, prepaid by the Contractor, to the Engineer, or as otherwise advised.

C. Two weeks from the date received shall be allowed for thorough examination of the samples by the Engineer.

D. Return: Samples are returnable, the Contractor shall arrange for return, prepaid shipping and pickup of each sample submitted.

E. Samples must be actual working units of materials to be supplied.

F. Samples shall be submitted by the Contractor for each substituted lighting fixture as requested for review by the Owner, Architect and Engineer.

1.5 QUALITY ASSURANCE

A. Fixtures, Emergency Lighting Units, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction. Provide only UL listed and labeled fixtures with UL listed wiring. Wiring shall be suitable for the fixture temperature listing.

B. Comply with NFPA 70.

C. FM Compliance: Fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM.

D. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.

E. Mockups: Provide lighting fixtures for room or module mockups where required by the Architect. Install fixtures for mockups with power and control connections.

1. Obtain Architect's approval of fixtures for mockups before starting installations.

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

3. Remove mockups when directed. Fixtures may be reinstalled in the Work with

approval of Architect.

4. Approved fixtures in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

F. UL Listing: All fixtures shall be manufactured in strict accordance with the appropriate and current requirements of the Underwriters' Laboratories, Inc. (Standards for Safety), and others as they may be applicable. A UL listing shall be provided for each fixture type and the appropriate label or labels shall be affixed to each fixture in a position concealing it from normal view.

G. Installer: All Installers shall have not less than five (5) years' experience in the installation of lighting fixtures of the type and quality shown.

H. Materials, equipment and appurtenances, as well as workmanship provided under this Section, shall conform to the highest commercial standard as specified and as indicated on the drawings.

I. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and NEC Articles 220, 410, and 510 as applicable to installation and construction of interior building lighting fixtures.

J. NEMA Compliance: Comply with applicable requirements of NEMA Standards Publication Numbers LE1 and LE2 pertaining to lighting equipment and LE4 pertaining to recessed luminaires.

K. IES Compliance: Comply with IES RP-1 pertaining to lighting practices and RP-15, regarding selection of illuminance values for interior of building.

L. UL Compliance: Comply with UL Standards, including UL 486A and B, pertaining to interior lighting fixtures. Provide interior lighting fixtures and components which are UL-listed and labeled.

M. CBM Labels: Provide fluorescent lamp ballasts which comply with Certified Ballasts Manufacturer's Association Standards and carries the CBM label.

N. NECA/IESNA Compliance: Comply with NECA/IESNA 500 — 1998 Standard, Installing Indoor Commercial Lighting Systems (ANSI).

1.6 COORDINATION

A. Fixtures, Mounting Hardware, and Trim: Coordinate layout and installation of lighting fixtures with ceiling system and other construction. Provide plaster frames, hangers, trim rings, and fittings, as required for each type of ceiling construction.

B. The Contractor shall coordinate switch and lighting control devices with door swings and other architectural features.

C. The Contractor shall be responsible for providing the required quantity of ballasts to

provide the control and operations of the lighting fixtures as indicated by the lighting controls on the Drawings. For example, where two switches are indicated to serve fixtures, then two ballasts per fixture shall be provided.

1.7 WARRANTY

A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Special Warranty for Batteries: Written warranty, executed by manufacturer agreeing to replace rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Special Warranty Period for Batteries: Manufacturer's standard warranty, but not less than [5] years from date of Substantial Completion.

C. Special Warranties for Fluorescent Ballasts: Written warranty, executed by manufacturer agreeing to replace fluorescent ballasts that fail in materials or workmanship within specified warranty period.

1. Special Warranty Period for Electronic Ballasts: Five years from date of manufacture, but not less than four years from date of Substantial Completion.

2. Special Warranty Period for Electromagnetic Ballasts: Manufacturers' standard warranty, but not less than two years from date of substantial completion.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.

2. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.

3. Battery and Charger Data: For emergency lighting units.

4. Ballasts: I for every 100 of each type and rating installed. Furnish at least one of each type.

5. Globes and Guards: I for every 20 of each type and rating installed. Furnish at least one of each type.

1.9 LEED REQUIREMENTS

A. Refer to Division 1 Section, "LEED Requirements" for description of work under this Division affected by LEED requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, products that may be incorporated into the Work include the products indicated in the Contract Documents.

B. Data listed and model number shown for each fixture type indicate minimum requirements and no exceptions will be made.

2.2 FIXTURES AND FIXTURE COMPONENTS, GENERAL

A. Metal Parts: Free from burrs, sharp corners, and edges.

B. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position.

D. Reflecting Surfaces: Minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.

2. Specular Surfaces: 83 percent.

3. Diffusing Specular Surfaces: 75 percent.

4. Laminated Silver Metallized Film: 90 percent.

E. Lenses, Diffusers, Covers, and Globes: 100 percent virgin acrylic plastic or annealed crystal glass, unless otherwise indicated.

1. Plastic for lenses and diffusers shall be formed of colorless 100% virgin acrylic as manufactured by Rhom & Haas, Dupont, or as acceptable. The quality of the raw material must equal or exceed IES, SPI and NEMA Specifications by at least 100%--which, as a minimum standard, shall not exceed a yellowness factor of 3 after 2,000 hours of exposure in the Fade-meter or as tested by an independent test laboratory. Acrylic plastic lenses and diffusers shall be properly cast, molded or extruded as specified, and shall remain free of any dimensional instability, discoloration, embrittlement, or loss of light transmittance for at least 15 years.

2. Lens Thickness: 0.125 inch (3 mm) minimum, unless greater thickness is indicated.

3. Glass used for lenses, refractors, and diffusers in incandescent lighting fixtures shall be tempered for high impact and heat resistance; the glass shall be crystal clear in quality with a transmittance of not less than 88%. For exterior fixtures, use tempered Borosilicate glass, Coming #7740, or as acceptable. For fixtures directly exposed to the elements and aimed above the horizontal with a radiant energy of 4.16 watts per square inch, or greater, use Vycor glass.

4. Where optical lenses are used, they shall be free from spherical and chromatic aberrations and other imperfections which may hinder the functional performance of the lenses.

5. Mechanical: All lenses, louvers, or other light diffusing elements shall be removable, but positively held so that hinging or other normal motion will not cause them to drop out.

6. Cleaning: All lenses shall be turned over to the Owner clean and free of dust.

2.3 LAMP HOLDERS

A. Incandescent: Body - Porcelain, screw shell, nickel-plated brass, prelubricated with silicone compound.

B. Fluorescent: Body - white urea plastic. Contacts: silver-plated phosphor bronze.

2.4 FINISHES

A. Painted Surfaces: Synthetic enamel, with acrylic, alkyd, epoxy, polyester, or polyurethane base, light stabilized, baked on at 350 degree Fahrenheit minimum, catalytically or photo-chemically polymerized after application.

B. Ceiling opening frames shall either be manufactured of non-ferrous metal, or be suitably rust-proofed after fabrication.

C. Selection: Unless otherwise noted, finishes shall be as selected by the **[Architect] [Engineer].**

D. Undercoat: Except for stainless steel, give ferrous metal surfaces a five-stage phosphate treatment or other acceptable base bonding treatment before final painting and after fabrication.

E. Unpainted non-reflecting surfaces shall be satin finished and coated with a stoved clear lacquer to preserve the surface. Where aluminum surfaces are treated with an anodic process, the clear lacquer coating may be omitted.

F. Unpainted Aluminum Surfaces: Finish interior aluminum trims with an anodized coating of not less than 7 mg per square inch, of a color and surface finish as selected by the

Architect. Finish exterior aluminum trims with an anodized coating of not less than 35 mg per square inch or a color and surface finish as selected by the Architect.

G. Porcelain Enamel Surfaces: Apply porcelain finishes smoothly. Finish shall be not less than 7.5 mils thick of non-yellowing, white, vitreous porcelain enamel with a reflectance of not less than 85%.

H. Fixtures: Manufacturer's standard, unless otherwise indicated.

1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects.

2. Metallic Finish: Corrosion resistant.

I. White Finishes: Minimum of 85 percent reflectance.

2.5 FLUORESCENT LAMP BALLASTS

A. Fluorescent Lamp Ballast Manufacturers: Provide quality ballasts by the Manufacturers listed below. Off-brand/generic ballasts shall NOT be acceptable.

1. Advance.

2. Lutron.

3. General Electric.

4. Valmont.

5. Universal

B. General Requirements: Unless otherwise indicated, features include the following:

1. Designed for type and quantity of lamps indicated at full light output.

2. Conform to UL 935 "Fluorescent - Lamp Ballasts".

3. Total Harmonic Distortion Rating: Less than 10 percent.

4. Sound Rating: A.

5. Conform to ANSI C82.1 Specifications for Fluorescent Lamp Ballast.

6. Warranty: Minimum 2 years of warranty after the date of acceptance for all types of ballasts.

C. Electronic Ballasts for Linear Lamps: Unless otherwise indicated, features include the following, besides those in "General Requirements" Paragraph above:

1. Certified Ballast Manufacturer Certification: Indicated by label.

2. Lamp Starting Method: Programmed/Rapid start.

3. Nominal Ballast Factor: 87 percent, minimum, unless otherwise indicated.

4. Power Factor: 90 percent, minimum.

5. Encapsulation: Without voids in potting compound.

6. Third Harmonic Content of Ballast Current: Less than 10 percent.

7. Conform to IEEE C62.41, Category A.

8. Conform to FCC Regulations, Part 15, Subpart J.

9. Lamp Current Crest Factor shall be less than 1.7.

10. Parallel Lamp Circuits: Multiple lamp ballasts connected to maintain full light output on surviving lamps if one or more lamps fail.

D. Electromagnetic Ballasts for Linear Lamps: Unless otherwise indicated, features include the following, besides those in "General Requirements" Paragraph above:

1. Type: Energy saving.

2. Certified Ballast Manufacturer Certification: Indicated by label.

3. Encapsulation: Without voids in potting compound.

E. Ballasts for Compact Lamps in Recessed Fixtures: Unless otherwise indicated, additional features include the following:

1. Type: Electronic or electromagnetic, fully encapsulated in potting compound.

2. Power Factor: 90 percent, minimum.

3. Operating Frequency: 20 kHz or higher.

4. Flicker: Less than 5 percent.

5. Lamp Current Crest Factor: Less than 1.7.

6. Transient Protection: Comply with IEEE C62.41 for Category Al locations.

7. Third Harmonic Content of Ballast Current: Less than 10 percent.

F. Ballasts for Compact Lamps in Non-Recessed Fixtures: Unless otherwise indicated, additional features include the following:

1. Power Factor: 90 percent, minimum.

2. Ballast Coil Temperature: 65 deg C, maximum.

3. Transient Protection: Comply with IEEE C62.41 for Category Al locations.

G. Ballasts for Dimmer-Controlled Fixtures: Comply with general and fixture-related requirements above for electronic ballasts.

1. Compatibility: Certified by manufacturer for use with specific dimming system indicated for use with each dimming ballast.

2. Ballasts shall be capable of operating lamps indicated in a smooth, stable, flicker-free range from full brightness (100%) down to 5% light output.

3. Ballast shall maintain full filament heat throughout the dimming range.

4. Ballast dimming circuitry shall be UL Class 2 fully insulated form ballast input power.

H. Ballasts for Low-Temperature Environments: As follows:

1. Temperatures 0 Deg F (Minus 17 Deg C) and Above: Electronic or electromagnetic type rated for 0 deg F (minus 17 deg C) starting temperature.

2. Temperatures Minus 20 Deg F (Minus 29 Deg C) and Above: Electromagnetic type designed for use with high-output lamps.

I. Ballasts for outdoor environments shall be of the low temperature type (0 degrees Fahrenheit).

J. Ballasts for special applications, as indicated, to minimize EMI/RFI shall comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.

2.6 HIGH-INTENSITY-DISCHARGE LAMP BALLASTS

A. General: Comply with ANSI C82.4, "Ballasts for High-Intensity - Discharge and Low-Pressure Sodium Lamps" and UL 1029 "High Intensity Discharge Lighting Fixtures". Unless otherwise indicated, features include the following:

1. Type: Constant wattage autotransformer or regulating high-power-factor type, unless otherwise indicated.

2. Operating Voltage: Match system voltage.

3. Minimum Starting Temperature: Minus 22 deg F (Minus 30 deg C) for single lamp ballasts.

4. Normal Ambient Operating Temperature: 104 deg F (40 deg C).

5. Open-circuit operation that will not reduce average life.

6. Auxiliary, Instant-on, Quartz Time Delay System: Automatically switches quartz lamp on when fixture is initially energized and when momentary power outages occur. Automatically turns quartz lamp off when high-intensity discharge lamp reaches approximately 60 percent light output.

B. High-Pressure Sodium Ballasts: Equip with a solid-state igniter/starter having an average life in pulsing mode of 10,000 hours at an igniter/starter case temperature of 90 deg C.

C. Instant Restrike Device: Solid-state, potted module, mounted inside high-pressure sodium fixture and compatible with high-pressure sodium lamps, ballasts, and sockets up to 150 W.

1. Restrike Range: 105- to 130-V ac.

2. Maximum Voltage: 250-V peak or 150-V ac RMS.

D. Ballasts shall be acceptable and listed by Underwriters' Laboratories, Inc. as Type 1 for non-weatherproof indoor conditions, and Type 2 for outdoor conditions; and ballasts shall be CBM-certified by ETL labels. Ballasts shall be high power factor, high efficiency and constant wattage.

E. Operating Environment: Indoor heated or air conditioned spaces - 10°C to 40°C (50°F to 105°F) ambient. Outdoors or unheated spaces: -29°C to 40°C (-20°F to 105°F). Insulation: Class H, 180°C (375°F) when tested in accordance with UL and CBM Standards.

F. Electrical Characteristics: Ballasts shall be designed for single frequency operation, 60 Hz nominal and shall operate at the nominal voltages indicated on the label, 120 volt and/or 277 volt, as required. Drop-out voltages: 66 percent of nominal. Suitable to operate within plus or minus 10 percent voltage variation.

G. Secure ballasts firmly in lighting fixtures to prevent vibrations.

2.7 EMERGENCY BATTERY PACKS:

A. Unless otherwise indicated, features include the following:

1. Conform to UL 924 "Emergency Lighting and Power Equipment"

2. Conform to NFPA 101 and International Building Code (IBC) requirements.

3. Initial Light Output: Provide as indicated.

4. Illumination time: 90 minutes, minimum.

5. Battery: Long life, high temperature, maintenance-free Nickel-Cadmium battery with test switch.

6. Self-Testing Diagnostics: Provide as indicated.

7. Cold Weather Operation: Provide as indicated.

8. Warranty: Minimum 5 year full product warranty.

9. Manufacturers: Provide specification grade emergency battery ballasts by the Manufacturers listed below. Off-brand/generic ballasts shall NOT be acceptable.

   a. Lithonia
   b. Bodine
   c. Iota

2.8 EXIT SIGNS

A. General Requirements: Comply with UL 924, "Emergency Lighting and Power Equipment", and the following:

   1. Sign Colors and Lettering Size: Comply with authorities having jurisdiction.

B. Internally Lighted Signs: As follows:

   1. Lamps for AC Operation: Light-emitting diodes (LED), 25 + years rated lamp life.

2.9 LAMPS

A. Fluorescent Color Temperature and Minimum Color-Rendering Index: 3500K and 85 CRI, unless otherwise indicated. **[Lamps shall be low mercury environmentally responsible (TCLP Compliant).]**

   1. Fluorescent Lamps - Outdoor: High output, cool white, lengths as required.

B. Noncompact Fluorescent Lamp Life: Rated average is 20,000 hours at 3 hours per start when used on rapid-start circuits.

C. Metal-Halide Color Temperature and Minimum Color-Rendering Index: 3600 K and 70 CRI, unless otherwise indicated. Supply coated or clear lamps as recommended by the Manufacturer.

D. Incandescent Lamps:

   1. "A" Style, inside frosted, 130 Volt, unless otherwise indicated.

   2. Tungsten Halogen PAR lamps.

E. Lamps shall conform to ANSI Standards C78 series and shall be as manufactured by General Electric, Philips, or Sylvania.

2.10 FIXTURE SUPPORT COMPONENTS

A. Comply with Division 16 Section, *Common Work Results for Electrical* and Division 16 Section, *Electrical Hangers and Supports,* for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: I/2-inch (12-mm) steel tubing with swivel ball fitting and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch (12-mm) steel tubes with single canopy arranged to mount a single fixture. Finish same as fixture.

D. Rod Hangers: 3/16-inch- (5-mm-) minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

F. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by fixture manufacturer.

G. Recessed fixtures shall be removable from below to allow access to outlet/junction boxes in ceiling spaces.

H. Each fixture shall be supplied with necessary straps, supports, or hangers, or other miscellaneous materials and devices to install them in a satisfactory manner to conform to architectural treatment and finishes in area in which they are to be installed. Consult all Mechanical, Architectural and Structural Plans and related Contract Documents to be familiar with all necessary details for proper fixture placement. Failure to do so will not relieve the Contractor of responsibility of furnishing all necessary material, complete to perform function intended for indicated lighting system.

2.11 FIXTURES

A. Fixture: Type A

1. Voltage: 277 VAC.

2. Mounting: Recessed ceiling

3. Nominal Dimensions: 2' x 4' x 5 1/4".

4. Lamps: (3) T-8 32 Watt Fluorescent.

5. Ballast Types and Features: Electronic less than or equal to 20% total harmonic distortion.

6. Lens: 24 cell 3" deep anodized specular parabolic louver.

7. External Finish: White painted parts finish with high-gloss baked enamel with

five-stage iron-phosphate pretreatment.

8. Trim and Hardware: Spring-loaded door latches, Black reveal floating louver. Die-formed heavy-gauge hinges.

9. Other Features: Two channel covers ballasts for two level illumination, and "ZR" reflector.

10. Manufacturers:

    a. Lithonia 2PM3N Series
    b. Columbia
    c. Hubbell
    d. Daybrite

B. Fixture: Type A

1. Voltage: 277 VAC.

2. Mounting: Recessed ceiling

3. Nominal Dimensions: 2' x 4' x 5 1/4".

4. Lamps: (4) T-8 32 Watt Fluorescent.

5. Ballast Types and Features: Electronic less than or equal to 20% total harmonic distortion.

6. Lens: 24 cell 3" deep low iridescent anodized diffuse silver parabolic louver.

7. External Finish: White painted parts finish with high-gloss baked enamel with five-stage iron-phosphate pretreatment.

8. Trim and Hardware: Spring-loaded door latches, Black reveal floating louver. Die-formed heavy-gauge hinges.

9. Other Features: Two channel covers ballasts for two level illumination, and "ZR" reflector.

10. Manufacturers:

    a. Lithonia 2PM3NG Series
    b. Columbia
    c. Hubbell
    d. Daybrite

C. Fixture: Type A

1. Voltage: 277 VAC.

2. Mounting: Recessed ceiling

3. Nominal Dimensions: 2' x 4' x 5 $^{1}/4$".

4. Lamps: (3) T-8 32 Watt Fluorescent.

5. Ballast Types and Features: Electronic less than or equal to 20% total harmonic distortion.

6. Lens: 24 cell 3" deep low iridescent anodized diffuse silver parabolic louver.

7. External Finish: White painted parts finish with high-gloss baked enamel with five-stage iron-phosphate pretreatment.

8. Trim and Hardware: Spring-loaded door latches, Black reveal floating louver. Die-formed heavy-gauge hinges.

9. Other Features: Two channel covers ballasts for two level illumination, "ZR" reflector and 1400 lumen emergency batter ballast.

10. Manufacturers:

    a. Lithonia 2PM3NG Series
    b. Columbia
    c. Hubbell
    d. Daybrite

D. Fixture: Type A

1. Voltage: 277 VAC.

2. Mounting: Recessed ceiling

3. Nominal Dimensions: 2' x 4' x 5 1/4".

4. Lamps: (4) T-8 32 Watt Fluorescent.

5. Ballast Types and Features: Electronic less than or equal to 20% total harmonic distortion.

6. Lens: 24 cell 3" low iridescent anodized diffuse silver parabolic louver.

7. External Finish: White painted parts finish with high-gloss baked enamel with five-stage iron-phosphate pretreatment.

8. Trim and Hardware: Spring-loaded door latches, Black reveal floating louver. Die-formed heavy-gauge hinges.

9. Other Features: Two channel covers ballasts for two level illumination, "ZR" reflector and 1400 lumen emergency battery ballast.

10. Manufacturers:

    a. Lithonia 2PM3NG Series
    b. Columbia
    c. Hubbell
    d. Daybrite

E. Fixture: Type A

1. Voltage: 277 VAC.

2. Mounting: Air craft cable suspended

3. Nominal Dimensions: 96" x 9.25" x 4".

4. Lamps: (3) T8-32W fluorescent.

5. Ballast Types and Features: Electronic less than or equal to 20% total harmonic distortion.

6. Lens: Uplight and downlight with windowed perforated baffles (light gray) in downlight section. Extended performance reflector system (EP).

7. External Finish: Aluminum finish.

8. Trim and Hardware: Die formed aluminum.

9. Other Features: Flat endcaps. Two-lamp ballasts for two level illumination.

10. Manufacturers:
    a. Finelite 8PW Series
    b. Mark
    c. Ledalite
    d. Litecontrol

F. Fixture: Type A

1. Voltage: 277 VAC.

2. Mounting: Air craft cable suspended

3. Nominal Dimensions: 48" x 9.25" x 4".

4. Lamps: (3) T8-32W fluorescent.

5. Ballast Types and Features: Electronic less than or equal to 20% total harmonic distortion.

6. Lens: Uplight and downlight with windowed perforated downlight section.

7. External Finish: Aluminum finish.

8. Trim and Hardware: Die formed aluminum.

9. Other Features: flat endcaps. Two-lamp ballasts for two level illumination.

10. Manufacturers:
    a. Finelite 8PW Series
    b. Mark
    c. Ledalite
    d. Litecontrol

G. Fixture: Type B

1. Voltage: 277-VAC.

2. Mounting: Recessed ceiling

3. Nominal Dimensions: 2' x 4' x 3 11/16".

4. Lamps: (3) T-8 32 Watt Fluorescent.

5. Ballast Types and Features: Electronic less than or equal to 20% total harmonic distortion.

6. Lens: #12 pattern acrylic, reverse apex.

7. External Finish: White painted parts finish with high-gloss baked enamel with five-stage iron-phosphate pretreatment.

8. Trim and Hardware: White powder pained door latches and flush steel door frame. Die-formed heavy-gauge hinges.

9. Manufacturers:

    a. Lithonia SP8 Series
    b. Columbia
    c. Hubbell
    d. Daybrite

H. Fixture: Type B

1. Voltage: 277-VAC.

2. Mounting: Recessed ceiling

3. Nominal Dimensions: 2' x 4' x 3 11/16".

4. Lamps: (3) T-8 32 Watt Fluorescent.

5. Ballast Types and Features: Electronic less than or equal to 20% total harmonic distortion.

6. Lens: #12 pattern acrylic, reverse apex.

7. External Finish: White painted parts finish with high-gloss baked enamel with five-stage iron-phosphate pretreatment.

8. Trim and Hardware: White powder pained door latches and flush steel door frame. Die-formed heavy-gauge hinges.

9. Other Features: 1400 lumen emergency battery ballast.

10. Manufacturers:

    a. Lithonia SP8 Series
    b. Columbia
    c. Hubbell
    d. Daybrite

I. Fixture: Type B

1. Voltage: 277 VAC.

2. Mounting: Recessed Ceiling.

3. Nominal Dimensions: 2' x 4' x 3 11/16 ".

4. Lamps: (3) T8 Watt Fluorescent.

5. Ballast Type: Electronic less than or equal to 20% total harmonic distortion.

6. Lens: #12 pattern acrylic, reverse apex.

7. External Finish: White painted parts finished with high gloss baked enamel with five-stage iron phosphate pre-treatment.

8. Trim and Hardware: White powder pained door latches, and white flush aluminum door frame, die-formed heavy gauge hinges door frame.

9. Other Features: 3 way Neoprene gasketed lens and door assembly for food service applications. Emergency battery ballasts.

10. Manufacturers:
    a. Lithonia SP8 Series
    b. Metalux

c. Hubbell
d. Daybrite

J. Fixture: Type B

1. Voltage: 277-VAC.

2. Mounting: Recessed ceiling

3. Nominal Dimensions: 2' x 2' x 5 1/4".

4. Lamps: (3) CF40 Watt Fluorescent.

5. Ballast Types and Features: Electronic less than or equal to 20% total harmonic distortion.

6. Lens: 12 cell 3" deep anodized specular parabolic louver.

7. External Finish: White painted parts finish with high-gloss baked enamel with five-stage iron-phosphate pretreatment.

8. Trim and Hardware: Spring-loaded door latches, Black reveal floating louver. Die-formed heavy-gauge hinges.

9. Other Features: Two-ballasts for two level illumination, and "2W' reflector channel covers.

10. Manufacturers:

a. Lithonia 2PM3N Series
b. Columbia
c. Hubbell
d. Daybrite

K. Fixture: Type B

1. Voltage: 277 VAC.

2. Mounting: Recessed ceiling

3. Nominal Dimensions: 2' x 2' x 5 '/4".

4. Lamps: (3) CF40 Watt Fluorescent.

5. Ballast Types and Features: Electronic less than or equal to 20% total harmonic distortion.

6. Lens: 12 cell 3" deep anodized specular parabolic louver.

7. External Finish: White painted parts finish with high-gloss baked enamel with five-stage iron-phosphate pretreatment.

8. Trim and Hardware: Spring-loaded door latches, Black reveal floating louver. Die-formed heavy-gauge hinges.

9. Other Features: Two-ballasts for two level illumination, "2W' reflector channel covers and 1400 lumen emergency battery ballast.

10. Manufacturers:
    a. Lithonia 2PM3N Series
    b. Columbia
    c. Hubbell
    d. Daybrite

L. Fixture: Type C

1. Voltage: 277 VAC.

2. Mounting: Surface

3. Nominal Dimensions: 4' x 7" x 2 7/8".

4. Lamps: (2) T-8 32 Watt Fluorescent.

5. Ballast Types and Features: Electronic less than or equal to 20% total harmonic distortion.

6. Lens: Square basket wrap around with flat bottom acrylic diffuser.

7. External Finish: Five stage iron-phosphate pre-treatment. Painted parts finished with high-gloss, baked white enamel.

8. Trim and Hardware: Diffuser hinges to open from either side.

9. Manufacturers:
    a. Lithonia Type SB Series
    b. Columbia
    c. Hubbell
    d. Daybrite

M. Fixture Type D

1. Voltage: 277 VAC

2. Mounting: Stem suspended.

3. Nominal Dimensions: 25 5/16" diameter.

4. Lamps: (1) 400 Watt metal halide.

5. Ballast: HID ballast encased in canopy. (SAJ Option)

6. Reflector: Symmetrical reflector fabricated from die-cut, pre-finished anodized aluminum, with vertical lamp.

7. External Finish: 18 gauge cold-rolled steel round unit.

8. Trim and Hardware: 1/8" chrome plated steam with 30 degrees swivel canopy of injection molded white polycarbonate plastic.

9. Other Features: Wire guard

10. Manufacturers:
    a. SPI — SFB Series
    b. Forum
    c. Elliptipar
    d. LAM

N. Fixture Type D

1. Voltage: 277 VAC

2. Mounting: Stem suspended.

3. Nominal Dimensions: 25 5/16" diameter.

4. Lamps: (1) 400 Watt metal halide. (1) 100 Watt quartz

5. Ballast: HID ballast encased in canopy (SAJ option).

6. Reflector: symmetrical reflector fabricated from die-cut, pre-finished anodized aluminum; with vertical lamp

7. External Finish: 18 gauge cold-rolled steel round unit.

8. Trim and Hardware: 1/8" chrome plated steam with 30 degrees swivel canopy of injection molded white polycarbonate plastic.

9. Other Features: Quartz re-strike — 100 watt quartz lamp and switch relay. Wire guard.

10. Manufacturers
    a. SPI-SFB Series
    b. Forum
    c. Elliptipar
    d. LAM

0. Fixture Type D

    1. Voltage: 277 VAC

    2. Mounting: Stem suspended.

    3. Nominal Dimensions: 17-13/16 " x 23-3/8" diameter.

    4. Lamps: (1) 400 Watt metal halide.

    5. Ballast: HID ballast.

    6. Reflector: One piece enclosed and gasketed spun aluminum

    7. Other Features: Wire guard.

    8. Manufacturers
        a. Lithonia TE Series
        b. Daybrite
        c. GE
        d. Hubbell

P. Fixture Type D

    1. Voltage: 277 VAC

    2. Mounting: Stem suspended.

    3. Nominal Dimensions: 17-13/16" x 23-3/8" diameter.

    4. Lamps: (1) 400 Watt metal halide. (1) 100 Watt quartz

    5. Ballast: HID ballast.

    6. Reflector: One piece enclosed and gasketed spun aluminum

    7. Other Features: Quartz re-strike — 100 watt quartz lamp and switch relay. Wire guard.

    8. Manufacturers
        a. Lithonia TE Series
        b. Daybrite
        c. GE
        d. Hubbell

Q. Fixture Type D

    1. Voltage: 277 VAC

2. Mounting: Stem suspended.

3. Nominal Dimensions: 17" x 25-3/4" diameter.

4. Lamps: (1) 400 Watt metal halide. (1) 100 Watt quartz

5. Ballast: Fluorescent dimmable ballast.

6. Reflector: Heat-resistant borosilicate glass reflector/refractor.

7. Other Features: Quartz re-strike — 100 watt quartz lamp and switch relay. Wire guard.

8. Manufacturers
   a. Lithonia TPGE Series
   b. Daybrite
   c. GE
   d. Hubbell

R. Fixture Type E

1. Voltage: 277 VAC

2. Mounting: Wall mount

3. Nominal Dimensions: 18 I/2 " x 6 ^{1}/4 " x 7 1/4 "

4. Lamps: (2) 8 watt Halogen

5. External Finish: High impact thermoplastic housing is impact-resistant, scratch-proof, corrosion proof and UV stabilized

6. Battery: Maintenance free nickel cadmium

7. Available Manufacturers:
   a. Lithonia ELM4 Series
   b. Exitronix
   c. Emergi-Lite
   d. Prescolite

S. Fixture Type F

1. Voltage: 277 VAC.

2. Mounting: Recessed Ceiling.

3. Nominal Dimensions: 15 1/8" x 15 13/16" x 5 1/4 ".

4. Lamps (1) 42 Watt TRI-TUBE.

5. Reflector: 6" clear alzak, with painted white flange

6. Ballast Types and Features: Electronic fluorescent.

7. Manufacturers:
   a. Lithonia AF Series
   b. Hubbell
   c. Prescolite
   d. Lightolier

T. Fixture Type F

1. Voltage: 277 VAC.

2. Mounting: Recessed Ceiling.

3. Nominal Dimensions: 16 1/8 " x 13 % " x 6 ^{3}/4 ". (4 5/16" aperture)

4. Lamp: (1) MR16 — 75 WATT

5. Lens: Wall wash spread lens, with white painted flange.

6. Other Features: 277V to 24 Volt transformer, clear safety lens.

7. Manufacturers:
   a. Lithonia DLV-WSH Series
   b. Halo
   c. Hubbell
   d. Lightolier

U. Fixture Type F

1. Voltage: 277 VAC

2. Mounting: Recessed ceiling.

3. Nominal Dimensions: 13 5/8" x 15 7/8" x 7 1/4 ".

4. Lamp: (1) 42 watt compact fluorescent.

5. Reflector: 6" round diameter clear alzak wall washer type.

6. Ballast: Electronic fluorescent.

7. Manufacturers:
   a. Gotham AFW Series
   b. Halo
   c. Lightolier
   d. Prescolite

V. Fixture Type F

1. Voltage: 277 VAC

2. Mounting: Recessed.

3. Nominal Dimensions: 16 1/4" x 14'/2 " x 4 3/8".

4. Lamps: (1) MR-16-50 WATT

5. Lens: Specular Reflector with protective glass lens.

6. Trim and Hardware: Clear Acrylic Double Rings.

7. External Finish: Silver with clear acrylic dual rings.

8. Manufacturers:
   a. Prima Lighting Series 19 with NCH housing.
   b. Peachtree
   c. Hubbell
   d. Lightolier
   e. Halo

W. Fixture: Type F

1. Voltage: 277 VAC.

2. Mounting: Surface.

3. Nominal Dimensions: 7 '/2" x 4" 16".

4. Lamps: (I) 42 Watt compact fluorescent.

5. Lens: Faux Glass

6. Finish: Polished Chrome

7. Manufacturers:
   a. Winona Saturn 4622 Series
   b. Lightolier
   c. Hubbell
   d. Progess

X. Fixture Type G

1. Voltage: 277 VAC

2. Mounting: Recessed Ceiling.

3. Nominal Dimensions: 12" x 24" x 6".

4. Lamps: (2) 32 Watt T-8

5. Reflector: Specular Aluminum, Asymmetric Distribution with Parallel parabolic blade louver.

6. Ballast Types and Features: Electronic Fluorescent.

7. Manufacturers:

   a. Focal Point Focus 1 Series
   b. Ligholier
   c. Alera
   d. Columbia

Y. Fixture Type G

1. Voltage: 277 VAC

2. Mounting: Recessed Ceiling.

3. Nominal Dimensions: 12" x 36" x 6".

4. Lamps: (2) 32 Watt T-8

5. Reflector: Specular Aluminum, Asymmetric Distribution with Parallel parabolic blade louver.

6. Ballast Types and Features: Electronic Fluorescent.

7. Manufacturers:
   a. Focal Point Focus 1 Series
   b. Ligholier
   c. Alera
   d. Columbia

Z. Fixture Type G

1. Voltage: 277 VAC

2. Mounting: Recessed Ceiling.

3. Nominal Dimensions: 12" x 48" x 6".

4. Lamps: (2) 32 Watt T-8

5. Reflector: Specular Aluminum, Asymmetric Distribution with Parallel parabolic blade louver.

6. Ballast Types and Features: Electronic Fluorescent.

7. Manufacturers:
   a. Focal Point Focus 1 Series
   b. Ligholier
   c. Alera
   d. Columbia

AA. Fixture Type G

1. Voltage: 277 VAC.

2. Mounting: Surface.

3. Nominal Dimensions: 14 1/8" 0.

4. Lamps: (1) 22 Watt Circuline, (1) 32 Watt Circuline.

5. Ballast Types and Features: Electronic Fluorescent

6. Lens: Rounded molded white acrylic diffuser.

7. External Finish: White

8. Manufacturers:
   a. Lithonia 10977 Series
   b. Lightolier
   c. Hubbell
   d. Progress

BB. Fixture: Type H

1. Voltage: 277 VAC.

2. Mounting: chain or stem suspended.

3. Nominal Dimensions: 48" x 12" x 51/4".

4. Lamps: (2) T8-32W fluorescent.

5. Ballast Types and Features: Electronic less than or equal to 20% total harmonic distortion.

6. Lens: Open lamp industrial fixture.

7. External Finish: High gloss, baked enamel white finish.

8. Trim and Hardware: Channel die formed code gauge steel. Combination reflector and channel cover secured by captive quarter turn latch for

wireway access.

9. Manufacturers:

   a. Lithonia Type EJ Series
   b. Columbia
   c. Daybrite
   d. Hubbell

CC. Fixture: Type H

1. Voltage: 277 VAC.

2. Mounting: Recessed ceiling. 12' x 6" ceiling.

3. Nominal Dimensions: 15 " x 11 " x 7 $^{1}/4$ ".

4. Lamps: (2) 42 Watt PLT.

5. Reflector: 8" diameter clear alzak with double pendent apertured clear/frosted glass trim.

6. Ballast Types and Features: Electronic Dimming Fluorescent Ballast.

7. Other Features: Double frosted glass ring.

8. Manufacturers:
   a. Peachtree PFTU-8242C-ICE-D Series
   b. Halo
   c. Lightolier
   d. Prescolite
   e. Hubbell

DD. Fixture Type H

1. Voltage: 277 VAC.

2. Mounting: Recessed Ceiling.

3. Nominal Dimensions: 17 $^{1}/4$ " x 16 $^{3}/2$ " x 6 7/8 ".

4. Ballast Types and Features: Electronic Fluorescent.

5. Reflector Clear Alzak — 8" diameter with 5" field adjustable inner reflector and TBD color acrylic diffuser.

6. Lamps: 2/42 watt TRT.

7. Manufacturers:
   a. Gotham PDGF Series
   b. Lightolier
   c. Kirlin

d. Halo

EE. Fixture Type I (Not Used)

FF. Fixture Type J

1. Voltage: 277 VAC

2. Mounting: Recessed ceiling.

3. Nominal Dimensions: 12 15/16" x 15 13/16" x 9 1/8".

4. Lamp: (1) 150 W A-21

5. Reflector: 8" Open clear alzak.

6. Manufacturers:
   a. Lithonia A-8AR -SDT
   b. Halo
   c. Lightolier
   d. Prescolite

GG. Type K

1. Voltage: 120 VAC

2. Mounting: Under surface cabinet.

3. Nominal Dimensions: 33 $^{1}/2$ " x 5" x 1 1/8 ".

4. Lamps: (1) T5-8W, (1) T5 — 13W

5. Lens: Acrylic prismatic.

6. Ballast: Electronic Fluorescent.

7. Other Features: Optional fixture mounted rocker switch.

8. Manufacturers:
   a. Alkco HP-I38 Series
   b. Lithonia
   c. Hubbell

HH. Fixture Type K

1. Voltage: 277 VAC

2. Mounting: Surface.

3. Nominal Dimensions: ??" x 6" x 2.4" with flat endcaps.

4. Lamps: (2) 32 Watt T-8.

5. Ballast Types and Features: Electronic Fluorescent less than or equal to 20% total harmonic distortion.

6. Lens: Uptight and downlight with side perforated section, and Specular reflector system (Spec).

7. Exterior Finish: White Finish.

8. Manufacturers:
   a. Finelite Series 5 Wall Mount
   b. Mark
   c. Ledalite
   d. Light Control

II. Fixture Type L

1. Voltage: 277 VAC

2. Mounting: Recessed Ceiling

3. Moninal Dimensions: 19 'A " x 17 ^{3}/4 " x 9 3/16 ".

4. Lamps: (1) 70 Wattt metal halide.

5. Ballast Types and Features: Encased and potted ballast tray module.

6. Lens: Safety Glass.

7. Trim and Hardware: 16 gauge galvanized steel mounting frame.

8. Reflector: 8" clear alzak with white painted flange.

9. Manufacturers:
   a. Gotham AH Series
   b. Lightolier
   c. Halo
   d. Hubbell

JJ. Fixture Type M

1. Voltage: 277 VAC

2. Mounting: 80" Cable Suspension set (silver finish).

3. Nominal Dimensions: 16" diameter round x 20 ^{3}/4 " height.

4. Lamps (1) 4P1M 70 watt compact fluorescent.

5. Reflector: Clear 16" Acrylic Reflector.

6. Housing Finish: Extruded Aluminum with Silver Finish.

7. Ballast Type and Features: Electronic Dimming Fluorescent Ballast.

8. Manufacturers:

   a. Xenonlight Atrio Series
   b. Hubbell
   c. Lightolier
   d. Halo
   e. Prescolite

KK. Fixture Type N

1. Voltage: 277 VAC

2. Mounting: Surface.

3. Nominal Dimensions: 16.5" high x 9.5" diameter.

4. Lamps: 50 Watt Metal Halide.

5. Lens: Type 5 fresnel glass refractor.

6. Trim and Hardware: Cast Aluminum.

7. External Finish: color to be selected by the Architect.

8. Other Features: Wall mount bracket.

9. Manufacturers:
   a. Hanover MH9010WA Series
   b. Lumec
   c. Sterner
   d. Hubbell

LL. Fixture Type N

1. Voltage: 277 VAC

2. Mounting: Surface.

3. Nominal Dimensions: 17.5" diameter x 8.4" depth.

4. Lamps: 1-70 Watt UV shielding metal halide.

5. Lens: Ultraviolet stabilized high impact resistant, virgin injection molded pearlescent polycarbonate.

6. Base Plate: Marine grade die cast aluminum.

7. Finish:

8. Manufacturers:
   a. Kenall MR17FD-PP Series
   b. Lightolier
   c. Hubbell
   d. Prescolite

MM. Type N

1. Voltage: 277 VAC

2. Mounting: Surface.

3. Nominal Dimensions: 13 1/5" x 8 9/10" x 4".

4. Lamps: (1) 50 watt metal halide.

5. Lens: Ultraviolet stabilized high impact resistant, virgin injection molded polycarbonate, clear starburst

6. Base Plate: Marine grade die cast aluminum.

7. Manufacturers:
   a. Kenall MO13ED-P-MB Series.
   b. Lightolier
   c. Hubbell
   d. Prescoite

NN. Fixture Type 0 (Not Used)

00. Fixture Type P

1. Voltage: 277 VAC

2. Mounting: Surface.

3. Nominal Dimensions: 48 " x 4 3/8 " x 2 1/6".

4. Lamps: (2) 32 Watt T-8.

5. Trim and Hardware: Cold rolled formed steel.

6. External Finish: Five stage iron-phosphate white.

7. Other Features: Housing configuration for staggered strip fluorescent.

8. Manufacturers:
   a. Lithonia SS Series.
   b. Hubbell
   c. Metalux
   d. Daybrite

PP. Fixture Type P

1. Voltage: 277 VAC

2. Mounting: Surface.

3. Nominal Dimensions: 36 " x 4 3/8 " x 2 1/6".

4. Lamps: (2) 25 Watt T-8.

5. Trim and Hardware: Cold rolled formed steel.

6. External Finish: Five stage iron-phosphate high gloss white paint.

7. Other Features: Housing configuration for staggered strip fluorescent.

8. Manufacturers:
   a. Lithonia SS Series.
   b. Hubbell
   c. Metalux
   d. Daybrite

QQ. Fixture Type P

1. Voltage: 277 VAC

2. Mounting: Surface.

3. Nominal Dimensions: 24 " x 4 3/8 " x 2 1/6".

4. Lamps: (2) 17 Watt T-8.

5. Trim and Hardware: Cold rolled formed steel.

6. External Finish: Five stage iron-phosphate high gloss white paint.

7. Other Features: Housing configuration for staggered strip fluorescent.

8. Manufacturers:
   a. Lithonia SS Series.
   b. Hubbell

c. Metalux
d. Daybrite

RR. Type P

1. Voltage: 277 VAC

2. Mounting: Surface mounted.

3. Nominal Dimensions: 2 3/4" x 4' x 2 3/4 ".

4. Lamps: (1) 32W T8

5. Ballast: Electronic Fluorescent.

6. Manufacturers:
   a. Lithonia — S series
   b. Daybrite
   c. Hubbell

SS. Type P

1. Voltage: 277 VAC

2. Mounting: Surface mounted.

3. Nominal Dimensions: 2 3/4" x 3' x 2 3/4 ".

4. Lamps: (1) 32W T8

5. Ballast: Electronic Fluorescent.

6. Manufacturers:
   a. Lithonia — S series
   b. Daybrite
   c. Hubbell

TT Type P

1. Voltage: 277 VAC

2. Mounting: Surface mounted.

3. Nominal Dimensions: 2 3/4" x 2' x 2 3/4 ".

4. Lamps: (1) 32W T8

5. Ballast: Electronic Fluorescent.

6. Manufacturers:
   a. Lithonia — S series
   b. Daybrite
   c. Hubbell

UU. Fixture Type X

1. Voltage: 277 VAC.

2. Mounting Universal.

3. Nominal Dimensions: 11.75" x 7.5" x 2".
4. Lamp: Liquid Emitting Diode (LED).

5. Face Type: White Stencil.

6. Housing Color: White.

7. Letter Color: Per local jurisdictions requirements.

8. Manufacturers:
   a. Lithonia LQM Series
   b. Emergi-Lite
   c. Light Alarms
   d. Hubbell

VV. Type Z

1. Voltage: 277 VAC

2. Mounting: Wall mounted.

3. Lamps: (1) 100 Watt incandescent

4. Lens: Glass globe with guard

5. Other Features: Damp location listed.

6. Manufacturers:
   a. Rig-a-lite VP series
   b. Crouse Hinds
   c. Hubbell
   d. GE

WW. Fixture Type

1. Voltage: 277 VAC.
2. Mounting: Surface cove.

3. Nominal Dimensions:

4. Lamps: Shall be 50,000 hour 2.5 mm triphosphor-coated cold cathode, operating at 100 mA and producing 386 lumens per foot (warm while 30TC) Manufacturer shall submit ITL pholometric reports to substantiate.

5. Lampholders: Shall be UL listed (US and Canada) type IL (surface mounted) or type TL-R while electrical porcelain with phosphor bronze clips to electrically connect and retain the lamp.

6. Transformers: Shall be UL listed (US and Canada) and shall be the models designated on the shop drawings. Transformers are to be installed as close to lamps as possible in order to keep the secondary feeds as short as possible. Transformers shall be installed in an accessible location by installation: in an accessible electrical or maintenance closet, above a lay-in ceiling or above an access panel (18" x 18" minimum size). Transformer location shall not exceed 100 degrees F. To avoid any electrical noise interfering with computer, public address, or telecommunication systems, all cold cathode transformers shall be supplied from distribution transformers dedicated to lighting only. If distribution or isolation transformers are not available, cold cathode transformers must be fed from a dedicated circuit with separate neutral wiring. Additionally, all cold cathode transformers and associated conduits and wiring shall maintain a 36" separation from any computer, public address, or telecommunications wiring and equipment.

7. Wiring and Conduit: Cathode Lighting Systems, Inc. shall provide GTO-1.5 high voltage cable to be installed in strict accordance with the instructions on the shop drawings. Installing contractor shall provide conduit, conduit fillings, and ground wire. All components and installation methods provided by the installing contractor shall comply with the NEC (National Electrical Code) and applicable local codes.

8. Shop Drawings: Shall be CAD generated and shall be submitted for approval and future maintenance. Drawings shall show lighting layout, method of installation, and a complete bill of materials. Installing contractor is responsible for furnishing “as-built” dimensions or full-sized patterns as required on the shop drawings.

9. Dimming: System “INI” shall be specified as dimmable or non-dimmable. If dimming is required, specifier or contractor must verify with dimmer manufacturer that dimming system is compatible with normal power factor cold cathode transformers.

10. Manufacturers:

    a. Cathode-Lighting System – TNP Series

    b. National Cathode

XX. Fixture Type U

1. Voltage: 120 VAC.

2. Mounting: Recessed wall.

3. Nominal Dimensions: 7-3/4" x 3-1/4".

4. Lamps: (1) 16 Watt PLC.

5. Lens: Tempered prismatic clear glass.

6. Other Features: silicone gasket.

7. Manufacturers:
   a. Daltor C-3 Series
   b. Daybrite
   c. Lightolier
   d. Prescolite
   e. Hubbell

PART 3 EXECUTION

3.1 INSTALLATION

A. Fixtures: Set level, plumb, and square with ceiling and walls, and secure according to manufacturer's written instructions and approved submittal materials. Install lamps in each fixture.

B. Support for Fixtures independent of ceiling systems, ducts, and piping.

1. Install a minimum of four support system rods or wires for each fixture from structure above. Locate not more than 6 inches (150 mm) from fixture corners.

2. Support Clips: Fasten to fixtures and to ceiling grid members at or near each fixture corner.

3. Fixtures of Sizes Less Than Ceiling Grid: Arrange as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.

C. Suspended Fixture Support: As follows:

1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.

2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

4. Continuous Rows: Suspend from cable installed according to fixture

manufacturer's written instructions and details on Drawings. Provide alignment fittings as required for uniform, level installation of continuous rows of suspended fixtures.

D. Fixture installations with fixtures supported only by insecure boxes will be rejected. It shall be the Contractor's responsibility to support all lighting fixtures adequately, providing extra steel work for the support of fixtures if required. Any components necessary for mounting fixtures shall be provided by the Contractor. No plastic, composition or wood type anchors shall be used.

E. Setting and Securing: Set units plumb, square, and level with ceiling and walls, and secure according to manufacturer's printed instructions and approved shop drawings.

F. Support for Recessed and Semi-Recessed Fixtures: Installed units may not be supported from suspended ceiling support system. Install ceiling system support rods or wires at a minimum of four rods or wires per fixture located not more than 6 inches from the fixture corners.

1. Fixtures Smaller Than Ceiling Grid: Install a minimum of four rods or wires for each fixture and locate at corner of the ceiling grid where the fixture is located. Do not support fixtures by ceiling acoustical panels.

2. Fixtures of Sizes Less than Ceiling Grid: Center in the acoustical panel. Support fixtures independently with at least two 3/4-inch metal channels spanning and secured to the ceiling tees.

3. Recessed fixtures shall be provided with the proper plaster frame or suitable adapter to receive the finished ceiling construction.

4. Recessed lighting fixtures shall be suitable for the ceiling or wall material and construction in which they will be installed.

5. All recessed incandescent lighting fixtures shall be provided with thermal protection per NEC requirements.

6. Recessed mounted lighting fixtures shall be connected to a junction box with flexible conduit. Final connection to light fixture shall be with heat-resistant wire of the following type:

a. Recessed fluorescent 120 or 277 volt, No. 12 RHH or TFIHN.

b. Recessed incandescent 120 volt, No. 12 AF.

G. Each lighting fixture shall be rigidly supported from the building construction and shall include suspension hangers, devices, and extra steel work for fixture support where required.

1. Support all lighting fixtures adequately. Special supports shall be installed as required.

2. Luminaires shall be furnished with all necessary stems, plaster frames, hangers, for the safe support of the fixture. All supports for fixtures shall be adequate to support weight of the fixtures. All visible hanging devices and appurtenances shall have the same finish as the fixture unless specifically indicated otherwise.

H. Coordinate with the work of other trades to determine modifications required to make fixtures suitable for ceilings as installed and verify the types of ceiling construction prior to fixture fabrication. Determine that the suspension method and the flange arrangement for the fixtures coordinate with the ceiling type and its suspended system. Fixtures which are shipped to the project and do not fit, or which otherwise do not match the ceiling system, shall be returned for correction at no additional cost.

I. Lamping: Lamp units according to manufacturer's instructions.

J. Installation shall include receiving, checking, storage in a safe and approved area until they are required for installation, unpacking, assembly of separate fixture components where required, and complete wiring and connection including the provision of associated wiring and connection devices such as fittings, hangers, aligners, box covers, and similar hardware which may be required for certain fixtures, but are not detailed or scheduled with the fixtures.

K. Plaster frames or mounting frames shall be provided for all fixtures which require them and shall be suitable for the ceiling construction in which they will be installed.

L. Trim rings shall be painted to match the finish of the adjacent ceiling surface.

M. Fluorescent fixtures shall be shielded from the dimmed areas to eliminate bleed.

N. Fixtures in equipment rooms shall be positioned clear of equipment interference and yet provide adequate light for working around the equipment.

0. All lighting fixtures, when installed, shall be set free of light leaks, warps, dents, or other irregularities.

P. Pendant-type fixtures shall be hung at heights as required, and as shown on the Drawings.

Q. In certain areas shown on the Drawings, the locations of fixtures are approximate only and the exact locations and pendant lengths will be determined for each individual fixture by the Owner's Representative.

R. Install all lamps required, including replacements for burned out lamps, until final acceptance of the completed work. No lighting fixture or sign will be installed without lamps.

S. If permanent lighting fixtures are to be used in lieu of temporary lighting facilities during the construction period, this shall be done only as permitted by the Owner's Representative, who may require that new lamps be installed and fixtures cleaned at the time of turnover to the Owner.

T.

T. Lighting fixtures for general illumination, emergency lighting, and exterior lighting, shall be complete with all required accessories and attachments.

U. Fixtures shall bear UL label and shall be wired and installed in full compliance with applicable codes.

V. The omission of a type or quantity in this Specification shall not relieve the Contractor of
the responsibility of installing all required fixtures, of proper type, as shown on the Drawings.

W. Fixtures shall be recessed, surface, or pendant type, as specified, and shall include sockets, diffusers, ceiling canopies and stems, hickeys, and all other necessary accessories.

X. Where suspended ceilings with steel channels occur, outlets and fixtures shall be supported on members resting on the channel framework. In no case shall fixtures be supported from plasterboard, plaster, or acoustic material.

3.2 GENERAL INSTALLATION OF FIXTURES

A. Install interior lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation", NEMA Standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.

B. All recessed fixtures mounted in dry wall or plaster ceilings shall be complete with a suitable plaster frame or trim ring. All fixtures shall be mounted on or in ceilings in accordance with published recommendations of the manufacturers using bar or swing-way hangers, etc. These items shall be furnished as part of the fixture whether called for by catalog number or not.

C. All fixtures shall be installed in strict accordance with NEC Article 410 and shall properly and suitably support the weight of any fixture installed. All fixtures shall be supported independently of ceiling suspension system being attached to building structure.

D. Fixtures indicated to be pendant-mounted shall be suspended with single stem hanger, maximum 40" on center. Hangers shall have suitable means for vertical adjustment and built-in positive horizontal leveling provisions.

E. Regardless of requirements indicated in the Contract Documents, every fixture shall be of the type for the ceiling construction in or on which it is to be installed. It shall be the Electrical Contractor's responsibility to coordinate this with the Ceiling Contractor.

F. All fluorescent lighting fixtures having exposed (bare) lamps shall be provided with safety sleeves (one per lamp). Sleeves shall be "Arm-a-lite", as manufactured by Thermoplastic Process, Inc., or approved equal. Fixtures with wire guards and/or shielding (louvers, baffles, lenses) beneath the lamps shall not be considered as exposed.

G. Install flush-mounted fixtures properly to eliminate light leakage between fixture frame and finished surface.

H. Tighten connectors and terminals including screws and bolts in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and 486B, and the National Electrical Code.

3.3 CONNECTIONS

A. Ground equipment. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Advance Notice: Give dates and times for field tests.

C. Provide instruments to make and record test results.

D. Tests: As follows:

1. Verify normal operation of each fixture after installation.

2. Emergency Lighting: Interrupt electrical supply to demonstrate proper operation.

3. Verify normal transfer to battery source and retransfer to normal.

4. Report results in writing.

E. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

F. Corrosive Fixtures: Replace during warranty period.

3.5 CLEANING AND ADJUSTING

A. Clean fixtures internally and externally after installation. Use methods and materials recommended by manufacturer.

B. Adjust aimable fixtures to provide required light intensities.

C. Touch up luminaire finish at completion of work.

D. Replace all burned-out! non-operating lamps at the time of substantial completion.

E. Replace all fluorescent and high intensity discharge lamps that fail within three (3) months of Substantial Completion.

F. Replace all metal halide lamps with noticeable color shift.

G. Replacement Lamps: At the time of substantial completion and prior to field tests, replace lamps in interior lighting fixtures which are observed to be noticeably dimmed after Contractor's use and testing. Furnish stock or replacement lamps as specified in this Section, Paragraph "Extra Materials". Deliver replacement stock as directed. Refer to Division 1 Sections for the replacement/restoration of lamps in interior lighting fixtures, and where used, the temporary lighting prior to time of substantial completion.

3.6 DEMONSTRATION

A. Provide a minimum of four (4) hours of training and demonstration of luminaire operations, setting, aiming, adjustment, and maintenance.

END OF SECTION 265100

SECTION 265600 - EXTERIOR LIGHTING

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 exterior lighting units with luminaires, lamps, ballasts, poles/support structures, and accessories.

B. Related Sections include the following:

1. Division 16 Section, *Interior Lighting* for interior fixtures, lamps, ballasts, emergency lighting units, and accessories.

2. Division 16 Section, *Lighting Control Devices* for programmable lighting control systems, time switches, additional photoelectric relays, power relays and contactors.

1.3 DEFINITIONS

A. Lighting Unit: A luminaire or an assembly of luminaires complete with a common support, including pole, post, or other structure, and mounting and support accessories.

B. Luminaire (Light Fixture): A complete lighting device consisting of lamp(s) and ballast(s), when applicable, together with parts designed to distribute light, to position and protect lamps, and to connect lamps to power supply.

1.4 SUBMITTALS

A. Product Data: Provide dimensioned and detailed drawings in booklet form with separate sheets for each type of lighting unit indicated, arranged in order of lighting unit type and designation. Include data on features, accessories, finishes, and the following:

1. Materials and dimensions of luminaires and poles.

2. Certified results of independent laboratory tests for fixtures and lamps for electrical ratings and photometric data. Include manufacturer and model number of fixture being submitted.

3. Lamp ANSI designation, initial and mean lumen output, average-rated hours of lamp life and lamp mortality curve, and color temperature and color rendering index.

4. Ballast ANSI designation; electrical characteristics, including voltages, lamp and line operating and starting amperes, watts and watt losses, percent of allowable line voltage variation range and lamp crest factor; minimum lamp starting temperature; and normal and maximum ballast operating temperature.

5. Ballast CBM approval and UL listing, volts, lamp and input amperes, input watts, and minimum lamp starting temperature.

6. Poles and standards dimensions, details of hand holes and wire entries, mast or bracket arms and connection to poles, wind load and deflection, and finishes.

7. Steel, power installed, auger type pole foundation dimensions, corrosion resistance, pullout and overturning resistance for the soil conditions of the site, and bolt circle data.

B. Provide a complete computer data printout of illumination levels based on a grid system of multiples of spacing to mounting height for each fixtures type in this Specification.

C. Shop Drawings: Anchor-bolt templates keyed to specific poles and certified by manufacturer.

D. Samples for Verification: For lighting units or luminaires designated for sample submission in this Specification:

1. Lamps: Specified units installed.

2. Ballast: 120-V model of specified ballast type.

3. Finishes: For each finished metal used in support components

E. Product Certificates: Signed by manufacturers of lighting units certifying that products comply with requirements, including Ballast Test Report, indicating conformance with maximum 90 degrees C case temperature.

F. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

G. Record Documents: Accurately record actual location of each luminaire with the switching arrangements shown.

H. Submit pole load calculations, including EPA wind load calculations, for all poles. Calculations shall include all pole-mounted devices including luminaires, call stations, handholes, directional signs, and banners. Refer to this Section, Paragraph *"Fixtures"* for additional information. Wind resistance calculations shall be certified by a Registered Professional Engineer.

I. Submit point by point lighting calculations for layout shown on the Contract Drawings if utilizing lighting fixture(s) other than first-named fixtures in this Specification (Basis of Design). All calculations shall strictly comply with 'ES Standards. Indicate foot candle readings minimum 5'-O" on center along the horizontal plane.

J. Submit fixture schedule as follows:

1. Must be approved before any fixture is ordered.

2. Include, in detail, the following items:

a. Type
b. Wattage
c. Voltage
d. Efficiency
e. Suspension
f. Glassware
g. Finished diameters
h. Mounting Heights
i. Lamps
j. Locations
k. Remarks
i. Appurtenances

K. Maintenance Data: Submit maintenance data and parts list for each exterior lighting fixture and accessory; including *trouble-shooting* maintenance guide. Include that data, product data, and shop drawings in a maintenance manual, in accordance with requirements of Division 1.

1.5 SAMPLES

A. After shop drawing review and prior to release for manufacturing, the Contractor shall furnish one sample of each fixture in this Specification for which sample requirement is noted.

B. Shipping: The samples shall be complete with specified lamps and compatible ballast, ready for hanging, energizing, and examining, and shall be shipped, prepaid by the Contractor, to the Engineer, or as otherwise advised.

C. Two weeks from the date received shall be allowed for thorough examination of the samples by the Engineer.

D. Return: Samples are returnable, the Contractor shall arrange for return, prepaid shipping, and pickup of each sample submitted.

E. Samples must be actual working unit of materials to be supplied.

1.6 QUALITY ASSURANCE

A. Luminaires and Accessories: Listed and labeled as defined in NFPA 70, Article 100, for their indicated use, location, and installation conditions by a testing agency acceptable to authorities having jurisdiction.

B. ANSI/ASTM Compliance: Comply with applicable requirements of ANSI C2, *National Electrical Safety Code.*

C. FM Compliance: Units for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM.

D. Comply with recommended practices of Illuminating Engineering Society (IES).

E. All products shall comply with UL and shall be UL listed.

F. Manufacturer's Qualifications: Firms regularly engaged in manufacture of exterior building lighting fixtures of types and ratings required, whose products have been in satisfactory use in similar service for not less than five (5) years.

G. Installer's Qualifications: Firm with at least three (3) years of successful installation experience on projects with exterior lighting fixture work similar to that required for the project.

H. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and NEC Articles 25, 250, 410, and 501 as applicable to installation, and construction of lighting fixtures encompassed by this section.

I. NEMA Compliance: Comply with applicable requirements of NEMA Standards Publication No. LE 2 pertaining to lighting equipment.

J. IES Compliance: Comply with IES RP-8, 19, 20, and PB-15 pertaining to exterior, parking, and roadway lighting practices and fixtures.

K. UL Compliance: Comply with requirements of UL Standards, including Standards 486A and
486B, pertaining to exterior lighting fixtures. Provide exterior lighting fixture and components which are UL listed and labeled.

L. NFPA Compliance: Comply with applicable requirements of NFPA 78, *Lightning Protection Code,* pertaining to installation of exterior lighting fixtures.

M. Code compliance is mandatory. Nothing in the Drawings and Specifications implies acceptance of work not conforming to these codes. Where work is shown to exceed minimum code requirements, comply with the Drawings and Specifications.

N. Codes and Standards: Provide luminaires, poles, standards and appurtenances conforming to the following:

1. Conform to applicable sections of American Association of State Highway and Transportation Officials (AASHTO):

   a. LTS-1: Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals.

2. American National Standards Institute (ANSI):

   a. *C2:* National Electrical Safety Code.
   b. C78.1300: Specifications for High Pressure Sodium Lamps Series
   c. C82.4: Ballasts for High-Intensity-Discharge and Low-Pressure Sodium

Lamps (Multiple-Supply Type)

d. CI36.20: Roadway Lighting Equipment - Fiber-Reinforced Plastic (FRP) Lighting Poles

3. Conform to applicable sections of American Society for Testing and Materials (ASTM).

   a. B429: *Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.*

4. Conform to applicable sections of Certified Ballast Manufacturer's Association (CBM) Standards for Fluorescent Lamp Ballasts.

5. National Electrical Manufacturers Association (NEMA):

   a. FA1: Outdoor Floodlighting Equipment.
   b. OD3: Physical and Electrical Interchangeability of Photo Control Devices and Mating Receptacles.
   c. SH5: Tubular Steel, Aluminum, and Prestressed Concrete Poles.

6. Conform to applicable sections of National Fire Protection Association (NFPA) 70, *National Electrical Code.*

7 Underwriters Laboratories, Inc. (UL):

   a. 57: Electric Lighting Fixture
   b. 1029: High-Intensity-Discharge Lamp Ballasts
   c. 1572: High-Intensity-Discharge Lighting Fixtures

8. Conform to all local requirements for maximum pole heights and pole setback distances from property lines.

1.7 DELIVERY, STORAGE, AND HANDLING OF POLES

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Retain factory-applied pole wrappings on poles until just before pole installation. Handle poles with web fabric straps.

D. Deliver exterior lighting fixtures in factory-fabricated containers or wrappings, which properly protect fixtures from construction debris and physical damage.

E. Store exterior lighting fixtures in original wrappings in a clean dry space. Protect from weather, dirt, fumes, water, construction debris, and damage.

F. Handle exterior lighting fixtures carefully to prevent damage, breaking, and scoring. Do

not install damaged fixtures or components; remove units from site and replace with new.

G. Sequence exterior lighting installation with other work to reduce possibility of damage and soiling of fixtures during the remainder of the construction period.

1.8 WARRANTY

A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Special Warranty: Written warranty, signed by Manufacturer and Installer agreeing to replace external parts of luminaires and poles exhibiting a failure of finish as specified below. This warranty is in addition to, and not a limitation of, other rights and remedies Owner may have under requirements of the Contract Documents.

1. Protection of Metal from Corrosion: Warranty against perforation or erosion of finish due to weathering.

2. Color Retention: Warranty against fading, staining, and chalking due to effects of weather and solar radiation.

3. Warranty Period: Manufacturer's standard, but not less than three years from date of Substantial Completion for poles, and not less than one year from date of Substantial Completion for luminaires.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.

2. Glass and Plastic Lenses and Covers: 1 for every 100 of each type and rating installed. Furnish at least one of each type.

3. Ballasts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
4. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

1.10 COORDINATION

A. Furnish bolt templates and pole mounting accessories to installer of pole foundations.

1.11 LEED REQUIREMENTS

A. Refer to Division 1 Section LEED Requirements for description of work under this Division affected by LEED requirements.]

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include the products indicated in this Specification.

B. Data listed and model numbers shown in this Specification for each fixture type indicate minimum requirements. No exceptions will be made.

C. [Lighting fixtures shall be as set forth in this Specification. Substitutions of other fixtures which are truly equivalent or superior to those specified, provided the bid price is not increased, shall be given every reasonable consideration. However, any assumption by a Bidder or Vendor that a less expensive fixture is "equal" is made at his own risk.]

2.1 LUMINAIRES

A. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

B. Metal Parts: Free from burrs, sharp corners, and edges.

C. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.

D. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

E. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position. Provide for door removal for cleaning or replacing lens. Arrange to disconnect ballast when door opens.

F. Exposed Hardware Material: Stainless steel or as indicated on the Drawings.

G. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to

heat, and ultraviolet radiation.

H. Reflecting Surfaces: Minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.

3. Diffusing Specular Surfaces: 75 percent.

I. Lenses and Refractors: Materials as indicated. Use heat- and aging-resistant, resilient gaskets to seal and cushion lens and refractor in luminaire doors.

J. Photoelectric Relays: As follows:

1. Contact Relays: Single throw, arranged to fail in the on position and factory set to turn light unit on at 1.5 to 3 fc (16 to 32 lx) and off at 4.5 to 10 fc (48 to 108 lx) with 15-second minimum time delay.

2. Relay Mounting: In luminaire housing.

K. High-Intensity-Discharge Ballasts: Comply with ANSI C82.4 and UL 1029. Constant wattage autotransformer or regulating high-power-factor type, unless otherwise indicated. Provide ballast suitable for lamp specified, and to operate at the line voltage indicated.

1. Ballast Fuses: One in each ungrounded supply conductor. Voltage and current ratings as recommended by ballast manufacturer. Provide suitable fuseholders. Provide thermal protection devices to meet NFPA 70 Requirements.

2. Fuse Holder: Fuse holder shall be equal of Buss Model HEB-1 through 30 amp in the-line type, constructed of molded plastic in two sections. Load side shall have a captive nut and waterproof "0" ring. Provide Buss fast-acting type "BAF" or "SC" fuse of size indicated on the Drawings.

3. Single-Lamp Ballasts: Minimum starting temperature of minus 40 degrees C.

4. Open-circuit operation will not reduce average life.

5. High-Pressure Sodium Ballasts: Equip with a solid-state igniter/starter having an average life in pulsing mode of 10,000 hours at an igniter/starter case temperature of 90 degrees C.

6. Noise: Uniformly quiet operation, with a noise rating of B or better.

7. [Surge Protector: Hard-wired unit external to ballast case, rated for supply circuit line voltage, and encapsulated for circuit and moisture protection. Three-stage surge protection with three suppression modes provides 330-V peak clamping, line to neutral, line to ground, and neutral to ground. Pulse life is 500 3KA-8x20 microsecond impulses, and response time is less than

1 nanosecond. Internal fuse takes device off line on failure and lights a light-emitting diode failure indicator.]

L. Instant High-Pressure Sodium Restrike Starters: Solid-state, potted module, mounted inside luminaire.

1 Compatible with mogul-base high-pressure sodium lamps, ballasts, and sockets up to 150 W.

2. Restrike Range: 105- to 130-V ac.

M. Auxiliary, Instant-on, Quartz System: Automatically switches quartz lamp on when luminaire is initially energized and when momentary power outages occur. Automatically turns quartz lamp off when high-intensity-discharge lamp reaches approximately 60 percent light output.

1. Mount control components internal to ballast.

2. Connect to ballast with tap so quartz lamp operates at 120 V.

N. Lamps: Comply with the standard of the ANSI C78 series that is applicable to each type of lamp. Provide luminaires with indicated lamps of designated type, characteristics, and wattage. Where a lamp is not indicated for a luminaire, provide medium wattage lamp recommended by manufacturer for luminaire. Metal-Halide Color Temperature and Minimum Color-Rendering Index: 3600 K and 70 CRI, unless otherwise indicated.

2.3 LUMINAIRE SUPPORT COMPONENTS

A. Description: Comply with AASHTO LTS-3 for pole or other support structures, brackets, arms, appurtenances, base, and anchorage and foundation.

B. Wind-Load Strength of Total Support Assembly: Adequate to carry support assembly plus luminaires at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of 100 mph (160 km/h) with a gust factor of 1.3. Support assembly includes pole or other support structures, brackets, arms, appurtenances, base, and anchorage and foundation. Strength Analysis: For each pole type and luminaire combination, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

C. Finish: Match finish of pole/support structure for arm, bracket, and tenon mount materials.

D. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1. Materials: Will not cause galvanic action at contact points.

2. Mountings: Correctly position luminaire to provide indicated light distribution.

3. Anchor Bolts, Nuts, and Washers: Hot-dip galvanized after fabrication unless

stainless-steel items are indicated.

4. Anchor-Bolt Template: Plywood or steel.

E. Pole/Support Structure Bases: As indicated on the Drawings.

F. Provide poles with mast arms, brackets, and bases as indicated on the Drawings. Poles shall meet all requirements set forth in this Specification. Substitutions shall match exactly the characteristics of the pole specified in this Specification.

G. Mast arms and pole-top mounting brackets for luminaires shall be manufactured specifically for the pole and luminaire submitted.

H. Coordinate with pole and luminaire manufacturers for assembly details, wind-loading and vibration analysis, and compatibility of materials for electrolysis-free attachment and connection.

I. Structural and Mechanical Design: Use a safety factor of 5.0 for static and dynamic loading
of load-bearing components, including cable.

J. Concrete for Pole Foundations: Size per Drawings. Design Strength: 3000-psig 20.7-MPa, 28-day compressive strength. Provide ground rods as required. Rub concrete to a smooth finish.

K. Handholes: Provide manufacturer's reinforced type removable weatherproof gasketed coverplate. Provide welded 2-inch (12 mm) threaded grounding lug centered approximately 12 inches above the base. Hand holes shall have a minimum clear access opening of 2-1/2-inches x 5-inches, unless otherwise noted.

L. Base Cover: Each pole shall be provided with a two-piece base cover fabricated from the above-specified alloy. The cover shall be attached to the pole by means of tamperproof hardware.

M. Anchor Bolts: All anchor bolts shall be fabricated of hot rolled special quality carbon steel with minimum 50,000 psi yield strength, or as recommended by Manufacturer. Bolts shall be furnished with nuts and washers. All bolts and hardware shall be zinc electro-plated after fabrication.

N. Service Platforms:

1. Floor of service platform shall be a minimum of 26-inches x 54-inches or sufficient area for maintenance operation. Centered in the platform shall be a 24-inches x 14-inches access door hinged to open to the rear. The floor shall be all welded construction.

2. The backrail and side rails shall be at least 42-inches high. The side rails, back rails, -platform and light bar shall bolt together for one integral unit.

3. The platform shall be fastened to the pole in at least two places using galvanized

bolts and galvanized straps.

4. Platform shall be hot dipped galvanized ASTM A-123 after fabrication integrity (Manufacturer shall ship with the wire harness a copy of the test results).

5. Shop details approved by a licensed engineer shall be submitted to the Owner prior to fabrication.

0. Pole Climbing Steps, Safety Cable and Safety Belt:

1. Pole Climbing Steps and Safety Cable - Steel climbing steps shall begin approximately 15 feet above ground and shall be staggered on 15-inch centers to top of pole. Steps shall be grade 5-3/4-inch x 7-inches long round head bolts, hot dipped galvanized meeting ASTM-A307 or the equivalent. Bolts shall be fastened to brackets welded to the pole by spare nuts. Poles shall be equipped with galvanized safety cable at step initiation and step attached at top and bottom with welded brackets.

2. Safety Belt - One OSHA approved safety belt and climbing device assembly shall be provided to the Owner for use with safety cable assembly attached to pole.

2.4 FIXTURES

A. Type SA

1. Luminaire shall be a 175 watt metal halide decorative pole mounted site lighting fixture 240 volt with remote pole mounted ballast and black finish.

2. Luminaire shall be as manufactured by Antique Street Lamps Copenhagen Series or approved equivalent by Lumec or AAL.

3. The luminaire shall be equipped with 240 volt integral photo cell for automatic control.

4. Pole shall be 12' aluminum pole with black finish as manufactured by Antique Street Lamps CAT NO. CPAX-12-3 S4 with black finish or approved equivalent by Lumec or AAL.

5. The mounting arms shall be as manufactured by Antique Street Lamps CAT NO: EPAH4/1 or approved equivalent by Lumec or AAL. Finish shall be black to match luminaire and pole.

B. Type SC

1. Luminaire shall be solar Poweed LED type warning lighting fixtures.

2. Shell encasement shall be high impact resistant, ultraviolet stabilized with water tight clean lens.

3. Solar panel shall be encased in luminaire housing.

4. Battery shall be lead acid sealed and encased with an operating temperature of 40 to
100 degrees F.

5. Illuminance range shall be 1 mile.

6. Lamp color shall be white with a 1.3 candela intensity rating.

7. Flash rate shall be steady.

8. Nominal dimensions shall be 6.125" in diameter and 4.25 inches in height.

9. Luminaire shall be as manufactured by Premer Floats Model #501 or approved equivalent.

2.5 FINISHES

A. Comply with NAAMM's *Metal Finishes Manual for Architectural and Metal Products* for recommendations for applying and designating finishes.

B. Provide finishes on poles, mounting arms/brackets, and luminaires as indicated in the Lighting Fixture Schedule.

2.6 SPLICES, TAPS

A. All splices underground in hand holes or other wet locations shall be waterproof and made with Scotchcast 85 Multi-Mold Splicing Kits, or approved equal.

B. All taps in pole bases shall use suitable connectors such as Burndy Type K's and taped with two layers of 3M Scotch Brand or approved equal rubber tape and six layers of vinyl plastic electrical tape. Tap wiring to luminaire shall incorporate Bus type HEB waterproof in line fuseholder with this as recommended by ballast manufacturer and #12 XHHW conductors.

C. Splices in hand holes shall be supported on bricks 8-inches above bottom of handhole. Splices shall be kept to a minimum and are prohibited in locations other than hand holes, pull boxes or lighting unit bases, except for retaining circuitry of existing underground wiring where existing poles or wiring are distributed.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which roadway, parking and outdoor lighting fixtures are to be installed and substrate which will support lighting fixtures. Notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to

the Installer.

3.2 FIELD COORDINATION

A. The Contractor shall be responsible for all field coordination, including verification of property lines, right of ways and other utilities.

B. Contractor shall locate poles and underground conduits within property lines. Contractor shall locate poles in compliance with local setback requirements.

3.3 DEMOLITION

A. Remove all existing lighting poles, fixtures, bases, and wiring which are indicated to be removed on the Drawings, and/or are obstacles to construction.

B. Re-use lighting poles and/or luminaires indicated to be relocated on the Drawings.

C. Turn over any removed lighting poles and/or luminaires that are not being relocated/re-used to the Owner.

D. [Safely store poles and reuse in new courtyard area and walkways between the new building, garage and existing buildings.]

E. [Salvage the unused poles and fixtures to the electric shop and as directed by the construction manager.]

F. [Relocated poles with new lighting fixtures shall be connected to the new panel and control system in the new building.]

3.4 INSTALLATION

A. Concrete Foundations: Construct concrete foundations with 3000 pound, 28-day concrete.

1. Comply with details for reinforcement and for anchor bolts, nuts, and washers. Verify anchor-bolt templates by comparing with actual pole bases furnished.

2. Finish for Parts Exposed to View: Trowel and rub smooth. Comply with Division 3 Section, *Cast-in-Place Concrete* for exposed finish.

B. Install poles in compliance with ANSI C2, with Manufacturer's written instructions and as follows:

1. Use web fabric slings (not chain or cable) to raise and set poles.

2. Mount pole to foundation with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.

3. Secure poles level, plumb, and square. Provide shimming and grouting of pole

base to maintain luminaire in a true vertical position.

4. Grout void between pole base and foundation. Use nonshrinking or expanding concrete grout firmly packed in entire void space.

5. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

C. Luminaire Attachment: Fasten to indicated structural supports.

D. Luminaire Attachment with Adjustable Features or Aiming: Attach luminaires and supports to allow aiming for indicated light distribution.

E. Lamp luminaires with indicated lamps according to manufacturer's written instructions. Replace malfunctioning lamps.

F. Install exterior lighting fixtures at locations and heights as indicated in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's *Standard of Installation*, NEMA Standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.

3.5 UNDERGROUND DUCT LINES

A. Duct lines shall be polyvinylchloride (PVC) heavy wall plastic ducts for installation without concrete encasement. Where local codes do not prohibit, ducts may be supplied with pre-assembled conductors.

B. Conductors AWG size shall be as indicated on the drawings, minimum number 10 AWG. Conductors shall be type THW. Provide for each 2-wire circuit shown on the drawings a separate green grounding conductor sized in accordance with NEC. Connect to lighting standard as required.

C. Duct lines shall be installed in a trench minimum 30 inches below grade. Trench shall be cleaned of all rock, gavel or debris larger than 1/4 inch diameter. Duct lines shall rest on minimum 3-inch clean sand bed and shall have minimum 3 inches clean sand over cover. Trench earth backfill shall be free of rock, gravel or other debris. Open trenches shall be limited to 30 linear feet before backfilling.

D. Metal conduit sleeves of sufficient size shall be installed in concrete lighting standard bases to allow the entry/exit of branch circuit wiring. Sleeves shall be capped with bushings.

E. All elbows and all ducts installed above grade shall be rigid galvanized

steel.

3.6 BOLLARDS

A. Anchor bolts, base plates, associated hardware, etc., are specified under Paragraph, *Products.* Provide 3,000 psi concrete bases reinforced with 6.0 inch x 6.0 inch #4 wire

mesh and finishing 6.0 inch above finished grade unless otherwise noted. All exposed edges of concrete shall be chamfered. Baseplates shall be grouted to concrete bases to provide proper leveling.

3.7 GROUNDING

A. Ground fixtures and metal poles according to Division 16 Section, "Grounding and Bonding".

1. Ground metallic components of lighting fixtures, poles, and foundations. Connect luminaires to grounding system with No. 4 AWG conductor.

2. Install 10-foot (3-m) driven ground rod at each pole, exothermically welded to grounding conductor.

3.8 CONNECTIONS

A. Ground equipment: Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Ground metal poles/support structures according to Division 16 Section, "Grounding and Bonding" and per this Section, Paragraph "Grounding".

3.9 FIELD QUALITY CONTROL

A. Inspect each installed unit for damage. Replace damaged units.

B. Advance Notice: Give dates and times for field tests.

C. Provide instruments to make and record test results.

D. Tests and Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source, and as follows:

1. Measure light intensities at night if specific illumination performance is indicated. Use photometers with calibration referenced to NIST standards.

2. Check intensity and uniformity of illumination.

3. Check excessively noisy ballasts.

E. Prepare a written report of tests, inspections, observations and verifications indicating and interpreting results.

F. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

G. Set, adjust, and aim adjustable fixtures at night. Repeat procedure until units provide illumination acceptable to the Owner.

H. Provide for the replacement/restoration of lamps in exterior lighting fixtures, where used for temporary lighting prior to Date of Substantial completion.

I. At the Date of Substantial Completion, replace lamps in exterior lighting fixtures which are observed to be noticeably dimmed after Contractor's use and testing, as judged by the Architect.

3.10 CLEANING AND ADJUSTING

A. Clean units after installation. Use methods and materials recommended by manufacturer.

B. Adjust aimable luminaires and luminaires with adjustable lamp position to provide required light distributions and intensities, in night test of system. Verify that measured illuminance values comply with isolux plot diagram values and point-by-point calculations.

C. Touch up damage to finishes.

3.11 DEMONSTRATION

A. Provide a minimum of four (4) hours of demonstration of luminaire operation.

B. Upon completion of installation of exterior lighting fixtures and associated electrical supply circuitry, apply electrical energy to circuitry to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

3.12 LAMP REPLACEMENT AND PROVISION OF SPARE LAMPS

A. At time of substantial completion, replace lamps in luminaires which are observed to be not functioning properly after Contractor's use and testing at the discretion of the Engineer.

B. Provide stock or replacement lamps as specified in this Section, Paragraph, "Extra Materials".

END OF SECTION 265600

SECTION 270528.36 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Continuous, rigid, welded steel wire mesh cable tray system used in industrial, commercial, and telecommunications applications.

B. Cable tray systems are defined to include, but are not limited to, straight sections, supports and accessories.

1.2 RELATED DOCUMENTS

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

1.3 SUMMARY

A. Related Sections:

1. Division 27 00 00 Telecommunications Cabling Systems for voice and data cabling associated with system panels and devices.

B. Bidding Requirements:

1. Submit complete detailed proposals with line item cost representation for components and associated installation labor. Lump sum bids will not be accepted.
2. Include as part of the bid response the following items:
3. Installation schedule with proposed manpower assignments.
4. Resumes for project manager and lead technician for this project.
5. Review associated “E”, “TA” Series electrical, audiovisual/ telecommunications infrastructure drawings to verify that necessary conduit and w/ floor boxes will be provided. Understand and coordinate shared infrastructure locations for AV and voice/ data outlets. No additional infrastructure to support the telecommunications cabling systems (Inside plant/ outside plant) will be provided. Any discrepancies with the identified infrastructure to support these systems should be questioned in the form of a request for information (RFI) during the bidding process. Be responsible for any additional infrastructure requirements after receipt of contract for this project. No wiremold or surface mounted raceways shall be approved on this project.

1.4 REFERENCES

A. IEC 61537 (2001) – Cable Tray Systems and Cable Ladder Systems for Cable Management

B. NEMA VE 1-2002/CSA C22.2 No. 126.1-02 – Metal Cable Tray Systems

C. ANSI/NFPA 70 (2005) – National Electrical Code (NEC)

D. TIA 569-A (1998) and addendums – Commercial Building Standard for Telecommunications Pathways & Spaces

E. ASTM A 510 - Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel

F. ASTM A 380 – Specification for Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems

G. ASTM B 633 – Specification for Electrodeposited Coatings of Zinc on Iron and Steel

H. ASTM A 123 – Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

I. ASTM A 653 - Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality

J. Norm NF/A 91-131 for Galvanized Steel

K. Norm NF/EN 12-329 for Electrozinc Coating

L. Norm NF/EN/ISO 14-61 for Hot-Dipped Galvanized Steel

M. Norm NF 10-088-2 for Stainless Steel

1.5 SYSTEM DESCRIPTION

A. This section outlines the performance for the noted cable tray support systems, as indicated on the "TA" Series drawings. The tray system shall provide a common raceway for telecommunications cable into and out of the Telecommunications Rooms (TR). Cable tray systems shall also be installed above finished ceiling in the common area hallways that are located on all floors of the building. The common area cable tray is intended to support telecommunications cabling from any of the station cable wall/floor outlet locations on any floor. Each station cable wall/floor outlet shall have a configuration of conduit pipe run to the tray system to support the aforementioned station cabling. It is intended to have this tray system transition (via a Cable Dropout or Runway Radius Drop) into the ladder tray installed above the noted equipment racks to be located in the TR's.

1.6 DESIGN REQUIREMENTS

A. Maximum Deflection between Supports: L/240.

1.7 SUBMITTALS

A. Comply with requirements of Section 01 33 00 - Submittal Procedures.

B. Submittal data is to be submitted in a three ring binder, a continuous spiral binder, or plastic binding that allows the booklet to lie flat while open. Each booklet shall contain the below in the following order:

1. Cover Sheet.

   a. Include name of supplying contractor and project name.

2. Detailed Bill of Materials.

   a. Include a listing of: component quantities, equipment manufacturer, model number, and description of each component being supplied, and the specification paragraph or drawing sheet that corresponds to the product. Failure to provide this information will result in the rejection of submittals.

3. Product Data.

   a. Include a catalog sheet per product of equipment listed in the Detailed Bill of Materials, in the exact order as the Detailed Bill of Materials. Each catalog sheet shall describe mechanical, electrical and functional equipment specifications. The catalog sheet must also include a image of the product. Photocopy duplications of the manufacturer’s original equipment catalog sheets will be allowed as long as they provide adequate clarity of both the printed word and graphics/pictures. If more than one product is shown on the catalog sheet the intended product must be denoted by either an arrow or highlight.

4. Prequalification Certificate.

   a. Copy of the installing technician(s) certificate of completion from the manufacturer’s training school for the equipment being provided.

5. Manufacturer Qualifications

   a. Submit manufacturer's certification indicating ISO 9002 quality certified.

6. Design Calculations

   a. Verify loading capacities for supports.

7. Submit Factory-certified test reports of specified products, complying with IEC 61537, NEC, and NEMA VE 1/CSA C22.2 No. 126.1.

C. Shop Drawings are to be submitted on project standard full size and bound. Each shop drawing set is to include the below in the following order:

1. Title Sheet.

   a. Containing, at a minimum, a list of all drawings in the set and a symbols legend defining each symbol used in the package.

D. Coordination Drawings

1. Include floor plans and sections drawn to scale. Include scaled cable tray layout and relationships between components and adjacent structural and mechanical elements. Data presented on these drawings are as accurate as preliminary surveys and planning can determine. Field verification of all dimensions, routing, etc., is directed.

E. Cable Tray Drawings

1. Submit drawing indicating materials, finish, dimensions, and accessories. Show layout, support, and installation details.

1.8 QUALITY ASSURANCE

A. Source Limitations: Obtain cable tray components through one source from a single manufacturer.

B. Manufacturer Qualifications: ISO 9002 quality certified.

C. Comply with NFPA 70. National Electrical Code, Article 392: Cable Trays; provide UL Classification and labels.

D. Provide ETL test documentation showing cable compression/deformation testing.

1.9 COORDINATION

A. Coordinate layout and installation of cable tray with other installations.

1. Revise locations and elevations from those indicated as required to suit field conditions and as approved by the Architect.

B. Storage and Handling: Avoid breakage, denting and scoring finishes. Damaged products will not be installed. Store cable trays and accessories in original cartons and in clean dry space; protect from weather and construction traffic. Wet materials will be unpacked and dried before storage. Protect materials and finishes during handling and installation to prevent damage

C. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Cablofil, Inc., 8319 State Route 4, Mascoutah, IL, 62258. Phone: (618) 566-3230. Toll-Free: (800) 658-4641. Fax: (618) 566-3250. Website: www.cablofil.com. Email: info@cablofil.com or approved equal.

2.2 CABLE TRAY SYSTEM

A. Description: Cablofil EZ Tray continuous, rigid, welded steel wire mesh cable tray system.

1. Mesh System: Permits continuous ventilation of cables and maximum dissipation of heat.
2. Safety Edge: Continuous safety edge T-welded wire lip.
3. Wire Mesh: Welded at all intersections.

B. UL Classification: Straight sections 4 x 8, 12, and 18 inches (108 x 200, 300, and 450 mm), UL classified. Width of tray shall be determined based on not exceeding industry standards for fill ratios.

C. Material: Carbon steel wire, ASTM A 510, Grade 1008. Wire welded, bent, and surface treated after manufacture.

D. Finish for Carbon Steel Wire: Finish applied after welding and bending of mesh.

1. Electro-Plated Zinc Galvanizing: ASTM B 633, Type III, SC-1, or
2. Hot-Dip Galvanizing: ASTM A 123, or
3. Flat Black: Powder painted surface treatment using ASA 61 black polyester coating.

E. Nominal Dimensions:

1. Mesh: 2 x 4 inches (50 x 100 mm).
2. Straight Section Lengths: 80 inches (2,000 mm) and 118 inches (3,000 mm).
3. Width: [2 inches (50 mm)], [4 inches (100 mm)], [6 inches (150 mm)], [8 inches (200 mm)], [12 inches (300 mm)], [18 inches (450 mm)], [24 inches (600 mm)].
4. Depth: [4 inches (108 mm)].
5. Wire Diameter: 0.177 inch (4.5 mm), minimum.

F. Fittings: Field fabricated in accordance with manufacturer's instructions from straight sections.

G. Support System: Standard.

1. Wall Installation: CS Bracket. Maximum tray width of 12 inches (300 mm).
2. Trapeze Mounting to Ceilings: CS Profile. Maximum tray width of 18 inches (450 mm).
3. Ceiling Installation: CSC Bracket. Maximum tray width of 12 inches (300 mm).
4. Fasteners: As required by tray widths. Furnished by manufacturer.

H. Support System: Caloric FAS System.

1. Floor and Wall Installation: FAS Profile.
2. Wall Installation:

   a. FAS Universal Bracket. Maximum tray width of 24 inches (600 mm).
   b. FAS L Bracket. Maximum tray width of 12 inches (300 mm).

3. Ceiling Installation: FAS C Bracket. Maximum tray width of 12 inches (300 mm).
4. Fasteners: Not required.

I. Hardware: Hardware, including splice connectors and support components furnished by manufacturer.

2.3 ACCESSORIES

A. Shielding Divider Strips: Divider strips to follow contour of cable tray run for shielding to run power and control cables in same tray. Pre-galvanized steel, [4 x 1-1/2 inches (108 x 30 mm)].

B. Fittings: Tees, crosses, risers, elbows, radius tees, and other fittings as indicated, of the same materials and finishes as cable tray.

C. Grounding: GTA-2-2 grounding lugs for attachment on tray of continuous ground conductor fixing system.

2.4 NON-CONTINUOUS CABLE SUPPORTS

A. Non-continuous cable supports shall be used in any area above the finished ceiling where cable tray is not available.

B. Adjustable non-continuous cable support slings shall be used in corridors as outlined on “TA”

C. Non-continuous cable supports

1. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
2. Non-continuous cable supports shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables; cULus Listed.
3. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.
4. Non-continuous cable supports sized 1 5/16” and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap shall be removable and reusable and be suitable for use in air handling spaces.
5. Non-continuous cable supports shall have an electro-galvanized or G60 finish and shall be rated for indoor use in non-corrosive environments.
6. Non-continuous cable supports shall be ERICO CableCatTM J-hook series CAT12, CAT21, CAT32, CAT64, CAT21SS, CAT32SS, CAT64SS; CAT-CMTM Double J-Hook CAT100CM; CAT-CMTM U-hook series CAT200CMLN, CAT300CMLN; and CAT-CMTM retainer CATRT200CM, CATRT300CM or approved equal.

D. Adjustable non-continuous cable support sling

1. Constructed from steel and woven laminate; sling length can be adjusted to hold up to 425 4-pair UTP; rated for indoor use in non-corrosive environments. Rated to support Category 5 and higher cable, or optical fiber cable; cULus Listed.
2. Adjustable non-continuous cable support sling shall have a static load limit of 100 lbs.
3. Adjustable non-continuous cable support sling shall be suitable for use in air handling spaces.
4. If required, assemble to manufacturer recommended specialty fasteners including beam clips, flange clips, C and Z purlin clips.

5. Acceptable products: ERICO CADDY CableCat™ CAT425; or approved equal.

E. Non-continuous cable support assemblies from drop wire/ceiling

1. Fastener to wire/rod with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; cULus Listed.
2. Acceptable products: ERICO CADDY CAT124Z34, CAT126Z34, CAT214Z34, CAT216Z34, CAT324Z34 or CAT326Z34; or approved equal.

F. Non-continuous cable support assemblies from beam, flange

1. Fastener to beam or flange with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; cULus Listed.
2. Acceptable products: ERICO CableCatTM J-hook series CAT12, CAT21, CAT32, CAT64 with CADDY beam clamps and CADDY flange clips; or approved equal.

G. Non-continuous cable support assemblies from C & Z Purlin

1. Fastener to C or Z purlin with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments, cULus listed.
2. Acceptable products: ERICO CableCatTM J-hook series CAT12, CAT21, CAT32, CAT64 with CADDY Purlin hangers; or approved equal.

H. Non-continuous cable support assemblies from wall, concrete, or joist

1. Fastener to wall, concrete, or joist with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments, cULus listed.
2. Acceptable products: ERICO CableCatTM J-hook series CAT12, CAT21, CAT32, CAT64, with CADDY angle bracket; or approved equal.

I. Non-continuous cable support assemblies from threaded rod

1. Fastener to threaded rod with one non-continuous cable support, factory or jobsite assembled, rated for indoor use in non-corrosive environments, cULus Listed.
2. The multi-tiered support bracket shall have a static load limit of 300 lbs.
3. U-hooks and Double J-hook shall attach directly to threaded rod using standard nuts.
4. Acceptable products: ERICO CableCatTM J-hook, CAT12, CAT21, CAT32, CAT64 with CADDY CATHBA series; CAT-CMTM Double J-hook CAT100CM, CAT-CMTM Direct mount U-hook CAT200CMLN, CAT300CMLN; or AFAB series; or approved equal.

J. Cantilever-Mounted cable supports

1. U-hook shall be able to be assembled to a wide variety of wall mount brackets.
2. Spacing of individual U-hooks as needed, max of 4’ to 5’ apart.
3. U-hooks may have the optional attachment of a cable roller for ease in pulling cables.
4. Acceptable products: ERICO CAT-CMTM U-hooks CAT200CMLN, CAT300CMLN: CAT-CM roller assemblies CATRL200CM, CATRL300CM; CATWMCM bracket; or approved equal.

2.5 FIRE STOP CABLE PASS-THRU SLEEVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are limited to, the following:

1. Basis of design: Specified Technologies Inc.
2. Approved equal by:

   a. 3M Corporation.
   b. Hilti Corporation.
   c. Wiremold- Legrand Corporation.

B. Fire Rated Cable Pathways: STI EZ-PATH ™ Brand device modules comprised of steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill, the following products are acceptable:

1. Specified Technologies Inc. (STI) EZ-PATH Series 44 Fire Rated Pathway
2. Specified Technologies Inc. (STI) EZ-PATH Series 33 Fire Rated Pathway

PART 3 - EXECUTION

3.1 EXAMINATION

A. Exam areas to receive cable management system. Notify the Architect of conditions that would adversely affect the installation or subsequent utilization of the system. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install cable tray level and plumb according to manufacturer's written instructions, Coordination Drawings, original design, and referenced standards.

B. Install cable management system at locations indicated on the drawings and in accordance with manufacturer's instructions. Install the cable tray system directly above the racks positioned within the space to allow for ease in cable management to and from the racks. Provide firestopping at penetration into/ out of Telecommunication rooms..

C. Load Span Criteria: Install and support cable management system in accordance with span load criteria of L/240.

D. Cutting:

   a. Cut cable tray wires in accordance with manufacturer’s instructions.
   b. Cable tray wires must be cut with side-action bolt cutters with offset head to ensure integrity of protective galvanic layer.
   c. Remove burrs and sharp edges from cable trays.

E. Install cable management system using hardware, splice connectors, support components, and accessories furnished by manufacturer.

F. Install expansion connectors where cable tray crosses building expansion joint and in cable tray runs that exceed 90 feet.

G. Ground cable tray according to manufacturer's written instructions.

H. The cable tray and ceiling installation shall allow for re-entry to accommodate additional cable to be pulled from all occupied spaces to their respective IDF locations on each floor.

I. Provide bend limiters to maintain cable type bend radius whenever cable exists cable tray into TR rooms.

J. Provide radius kits at all 90-degree turns.

K. Certified Installers: Cable tray installers must have successfully completed Cablofil's Certified Installer program.

3.3 FIRESTOPPING

A. Firestopping In Telecommunications Room At Cable Tray Entrance

1. Install EZ Path Series 44 as shown on contract drawings.

B. Firestopping where cable tray passes through a rated wall assembly.

1. Install quantity of EZ Path series 33 or series 44 to 100% fill ratio of the size of cable tray at entrance to opening.

C. General: Install through-penetration firestop systems in accordance with Performance Criteria and in accordance with the conditions of testing and classification as specified in the published design.

D. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of firestopping products.

END OF SECTION 270528.36

SECTION 270528.48 MULTIMEDIA CONNECTION WALL BOX

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Multimedia Connection Wall Box.

B. Related Sections include the following:

1. Division 27 Electrical Section Telecommunications Systems, Audiovisual Systems, wiring, connections, and installation of associated conduit infrastructure.

1.2 PERFORMANCE REQUIREMENTS

A. General: Wall boxes provide interface between power and telecommunication cabling in a wall mount flat panel display locations requiring power and/or communication device outlets.

B. Wall Mounted Connector Assembly: Rubber cable pass thru door and cover assembly along with connector mounting panel inserts.

C. Labeling: Wall boxes shall bear the “cULus mark” issued by UL for units complying with both US and Canadian Standards.

D. Standards: Comply with the following:

1. National Electrical Code.

1.3 SUBMITTALS

A. Comply with Section 01 33 00 Section *Submittal Procedures*.

B. Submittal data is to be submitted in a three ring binder, a continuous spiral binder, or plastic binding that allows the booklet to lie flat while open. Each booklet shall contain the below in the following order:

1. Cover Sheet.

a. Include name of supplying contractor and project name.

2. Product Data.

a. Include a catalog sheet per product. Each catalog sheet shall describe mechanical, electrical and functional equipment specifications. The catalog sheet must also include a image of the product. Photocopy duplications of the manufacturer’s

original equipment catalog sheets will be allowed as long as they provide adequate clarity of both the printed word and graphics/pictures. If more than one product is shown on the catalog sheet the intended product must be denoted by either an arrow or highlight.

3. Informational Submittals.

   a. Manufacturer's installation instructions.

C. Shop Drawings are to be submitted on project standard full size and bound. Each shop drawing set is to include the below in the following order:

1. Detailed riser drawing indicating conduit runs and associated (box knockout) cables within.
2. Floor plans showing Wall box locations based on column grid lines.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are limited to, the following:

1. FSR Inc.
2. Approved equal

A. Multimedia Connection Wall Box: FSR product number PWB-100 complete with:

1. Cover PWB-100-WHT White.
2. Two (2) Low voltage backboxes
3. One (1) AC outlet box.

B. Overall box dimensions shall be as follows:

1. 11 inches wide by 5.25 inches high x 3.58 inches deep.

PART 3 - EXECUTION

3.1 EXAMINATION

A. With Installer present, verify that manufacturer's requirements for wall opening and infrastructure conditions have been satisfactorily met. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Verify exact locations of Wall box installation.

3.3 INSTALLATION

A. Install equipment in compliance with approved shop drawings and manufacturer's installation instructions.

B. Install in position and relationship to adjoining work indicated, securely anchored to supporting structure, sealed and finished, and in a manner, which produces a level box with square, plumb, and straight edges.

C. Telecommunications Cabling Wall box shall have a total of three separate EC with pull string at each box as follows:

1. One 3/4-inch EC from box to circuit panel. (Duplex AC Power)
2. Two 1-1/4 inch EC from box to telecomm cable tray A.F.C. One conduit run to lower Low voltage backbox and one conduit run to the upper Low voltage backbox.

D. Provide pull strings in each conduit at wall box location.

3.4 ADJUSTING

A. Adjust door and cover for proper operation.

3.5 PROTECTION

A. Protect installed equipment in original undamaged condition until Substantial Completion. Remove and provide new components or units that cannot be repaired to the satisfaction of the Architect.

END OF SECTION 270528.48

SECTION 27 41 00 - AUDIOVISUAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Division 1 - Applicable sections of Division 1 shall govern all work under this section.

B. 11 52 13 – Projection Screens

C. 27 05 28.48 – Multimedia Connection Wall Box

D. 27 05 28.50 Multimedia Flush Poke-Thru Device

E. 27 41 13 – Multimedia Floorbox

F. Audiovisual (AV) System Drawings

G. Other Drawings

1. Related Architectural Drawings; for reference only.
2. Related Electrical Drawings; for reference only.

1.2 REFERENCES

A. Building Industry Consulting Services International (BiCSi),"Telecommunications Distributions Methods Manual," Twelfth Edition.

B. Electronic Industries Association/Telecommunications Industry Association (EIA/TIA) -568B, "Commercial Building Telecommunications Wiring Standard"

C. EIA/TIA-569A, "Commercial Building Standard for Telecommunications Pathways and Spaces"

D. EIA/TIA-606A, “Administration Standard for the Telecommunications Infrastructure of Commercial Buildings”

E. EIA/TIA-607, “Commercial Building Grounding/Bonding Requirements”

F. National Electrical Code (NEC), 2008 - National Fire Protection Agency (NFPA) 70

G. Institute of Electrical and Electronic Engineers (IEEE) 802.3 Carrier Sense Multiple Access with Collision Detection (Ethernet 100BASE-T)

H. Federal Communications Commission (FCC), Title 47, Code of Federal Regulations, Part 68.

I. National Institution for Certification in Engineering Technologies (NICET)

J. International Communications Industry Association (ICIA).

1.3 DEFINITIONS

A. ADA: Americans with Disabilities Act

B. AV: Audiovisual

C. Bid: Herein, used interchangeably with “proposal”

D. CATV: Central or Master Antenna Television (broadband)

E. DSP: Digital Signal Processor

F. IR: Infrared

G. NIC: material and work which is Not In Contract and for which the Installer is not responsible except as otherwise detailed herein.

H. OFE: “Owner Furnished Equipment” which will be provided by The Owner. Be responsible for installing and integrating this equipment as detailed herein.

I. OFCI: “Owner Furnished Contractor Installed” Equipment which will be provided by The Owner. Be responsible for installing and integrating this equipment as detailed herein.

J. The term “shall” is mandatory.

K. The term “will” is informative.

L. The term “should” is advisory.

M. Term “provide” means furnish and install.

N. AV Consultant: Convergent Technologies Design Group, Inc.

O. Bidder: Qualified firm intending to tender a bid on the systems described herein.

P. Owner: (INSERT OWNER NAME)

Q. Construction Manager (CM) or General Contractor (GC): The representative responsible for general building construction and onsite coordination between sub-contractors

1.4 BID PROPOSALS

A. Itemized Bid Response

1. Each piece of equipment shall be individually priced and submitted with Bid Proposals. Provide itemized bid response to include equipment description, manufacturer, model

number, unit price, and quantity on a per room basis. All equipment prices shall reflect required modifications and accessories as needed for a complete and functioning system.

2. Non-equipment charges shall be outlined separately as a single line item on a per room basis. A sum of the audiovisual system total cost shall be provided with the bid proposal.

B. Contractor Qualification

1. Demonstrate at least three (3) years experience in the fabrication, programming, assembly, and installation of audiovisual presentation and remote control systems of similar magnitude and quality as specified for the subject job. Submit documentation to this effect with the bid response. Be an authorized sales and service center for all listed components and offerings in this specification.
2. References: Furnish no less than three (3) references for installations of similar size (dollar amount & quantity of spaces receiving integrated technology) and scope, performed throughout the Delaware area within the past three (3) years. At a minimum, reference information will include the reference company or institute name, contact person's name and title, telephone number, address, and detailed project description, project manager's name, and contact information of the organization that is responsible for day-to-day operation of the audiovisual installation.

C. Alternate Proposals

1. Any proposed alternate equipment choices should be requested in writing by the contractor prior to the proposal submission for approval. Each item on the alternate equipment list must be accompanied by catalog cut sheets and technical specifications.

D. Non-Equipment Charges, Including but not be limited to:

1. Engineering: Including all required design drawings, run sheets, instruction manuals, console layout, step-by-step user guide, etc.
2. Pre-Installation: Work performed on the Installer's premises including all fabrication, modification, assembly, rack wiring, etc.
3. Installation: Including all on-site installation and wiring, shop drawing, coordination and supervision, testing, checkout, Owner training, etc., performed on the Owner's premises.
4. General and Administrative: Including all shipping, insurance, and guarantees.

E. Owner Furnished Equipment (OFE, OFCI)

1. Identify any Owner Furnished Equipment assumed in the Bid Proposal to be installed and integrated under this contract. Identify all assumed Owner Furnished equipment within each room/space type that will be required to complete the AV systems installation.

F. State of the Art Development

1. Supply only the manufacturer's latest developed product. In cases where product development surpasses the criteria of the specification, inform the Architect and make the newer product available to the project at no additional cost. In no case shall discontinued or obsolete equipment be acceptable. The same requirement applies to software programs developed/updated during the warranty period.
2. Should a manufacturer discontinue a specified product, provide the manufacturer's recommended replacement at no additional cost to the owner. Should the manufacturer

have no direct replacement product, AV contractor shall propose a product of equal or greater specification from an alternate manufacturer at no additional cost to the owner.

3. Should a product recall by a specified manufacturer require temporary or permanent replacement of a product specified under this section, notify the Architect at the earliest possible time and arrange to replace the product in question as quickly as possible.

    a. Equipment found defective or subject to recall prior to scheduled installation shall not be delivered to the jobsite.
    b. Equipment defect or intended recall shall not relieve the AV Contractor from any contractual obligations with regard to delivery schedule of product.
    c. Under no circumstances shall arrangement for alternate product require the Owner to accept superseded equipment except on a temporary basis.

G. Service Contract

1. Submit the costs for a one-year service contract, renewable for up to three years, which shall commence with the completion of the two-year warranty period. These contracts shall be fixed-cost, and can be accepted at the option of the Owner.
2. The service contract shall include all of the services provided during the warranty period, including complete replacement or repair of defective equipment.

1.5 QUALITY ASSURANCE

A. Coordination

1. Coordinate this Section with work of other Project Manual sections and associated trades.
2. Specific references, herein, requiring coordination of certain work shall not obviate responsibility for other required coordination.

B. Standards and Codes

1. Comply with

    a. Local, state and federal codes
    b. Applicable National Electrical Code
    c. American National Standards Institute
    d. Underwriters' Laboratories, Inc. standards.

2. All equipment, material, accessories, and loose items provided by Contractor shall be new and shall conform to applicable requirements of the above-mentioned agencies.
3. If required by local authorities, provide certificates and labels indicating compliance with above-mentioned codes and standards where applicable.

C. Point of Contact

1. Designate to the Owner in writing, the responsible person who shall ensure timely and consistent communication with the Owner on progress of the contract. The designated representative shall have full knowledge of all engineering and production procedures and shall report status of the installation and upcoming work plans to the Owner's Project Manager and Consultant on a weekly basis.

2. Project manager shall have successfully managed not less than two (2) projects of similar size and scope (as defined in previous sections). Bid submission shall detail the percentage of time that the project manager and other key personnel will be involved with the project.

1.6 SCOPE OF WORK

A. Provide the following in accordance with Specifications and Drawings:

1. Submittals delivered in a timely manner as described hereinafter.
2. Verification of dimensions and other conditions at project site. Review conduit system as shown in electrical section of building construction documents and, where applicable, as built conditions. Notify Consultant, Architect, GC, and EC within four weeks after award of contract of any deficiencies or inadequacies in conduit system design.
3. Detailed design of Digital Signal Processor system "maps," including remote-control accommodations.
4. Power distribution within equipment racks including power connection to electrical outlets as described in electrical section of building construction documents.
5. Incidentals necessary for a complete working system.
6. Initial testing and adjustments, demonstration of system for approval, participation in acceptance tests, final adjustments as required.
7. Record Documents, "As-Built" drawings and Owners Manual.
8. Training of operating personnel.
9. Notify appropriate parties of conflicts in a timely manner.
10. Work cooperatively with other trades to resolve conflicts.

B. Special Insurance

1. Provide insurance fully covering all equipment against loss and damage during shipment, storage, installation, testing, adjustment and demonstration.

1.7 SYSTEM DESCRIPTION

A. Design Intent

1. Provide a complete and functioning audiovisual (AV) system inclusive of all hardware, software and training to meet or exceed the performance features outlined in this document.

B. Design Standards

1. The Owner's goal is to have available a cohesive and fully functional system. Therefore, part of the development efforts for successfully implementing the AV systems should include:

a. Install the system in a manner that complies with BiCSi and ICIA cable routing standards. Route all audio, video, and control cabling elements in a subtle, unobtrusive manner to maintain the architectural and visual integrity of the building.

b. Except where plenum cable is used above finished ceilings, it is required that all cabling be routed inside the comprehensive system of conduit. Floor and wall boxes shall serve as the primary interface points to the AV system.

c. Provide and install cover plates, connectors, and associated cabling to link all floor and wall boxes to all affiliated local and remote AV components. No wiremold or surface-mounted raceway will be permitted. The AV contractor shall coordinate faceplate materials, colors, and finishes with the faceplates used by other trades on the project and the architect to match aesthetics.

d. Provide and install security covers on any electronics with front panel controls that should not need to be adjusted after initial set-up. All components permanently mounted to rack rail systems shall be installed with industry accepted security screws.

e. All ceiling mounted AV equipment shall be secured to building structure.

f. No more than thirty lamp hours shall be expired for projection system set-up at the time of final systems acceptance. Should more hours than this be expired, the AV contractor shall replace the lamp at no cost to the Owner.

g. Steel cable security systems and padlocks to secure structure shall be provided for all surface mount loudspeakers, document cameras, video cameras, flat panel displays, and projectors. All padlocks provided for security shall be keyed to a single master key.

h. Provide intellectual property release and install an editable version of all master source code for all digital signal processing, remote control or microprocessor-based systems included on this project to an owner furnished personal computer. Also provide a hardcopy on portable media.

i. Provide necessary audio, video, RGBHV, HDMI, DVI, USB, and control signal repeaters, extenders, and amplifiers for any run greater than 30 feet and as needed to maintain required signal levels for receipt at destination device. All audio lines shall be balanced at the source, prior to any cable pull longer than 20 feet. There are no exceptions.

j. Video camera locations shall receive AC power from associated equipment rack low voltage transformers within 60 feet.

k. For each input/output point of interface to the system, provide a suitable length patch cord for owner use for every signal type present. Provide umbilical style cable management for any mobile solutions.

2. Performance Standards: Unless restricted by the published specifications of a particular piece of equipment, or unless otherwise required, the following minimum performance standards shall be met by each system:

a. Analog Audio:
   1) S/N (including crosstalk and hum): 75 dB minimum
   2) Total Harmonic Distortion: 0.5% maximum from 30 Hz to 15,00Hz.
   3) Frequency Response: Flat within +1.0 dB, 30 Hz to 15,000Hz.

b. Analog Video:
   1) S/N (peak to RMS) unweighted DC to 4.2 MHz: 45-dB minimum
   2) Crosstalk, unweighted DC to 4.2 MHz: 45 dB minimum
   3) Frequency Response(composite): Within +0.5 dB to 10 MHz

4) Frequency Response(component): Within +0.5 dB to 100 MHz
5) Line and Field Tilt: 2% maximum
6) Differential Gain: 3% maximum
7) Differential Phase: 2 degrees maximum

c. Digital Visual Interface (DVI):
1) TMDS Channel Pixel Clock Support up to 165 MHz
2) EDID Support DDC

d. High Definition Multimedia Interface (HDMI):
1) TMDS Channel Pixel Clock Support up to 340 MHz
2) Bandwidth for 1080p signals Support Deep Color and 3D
3) EDID and CEC Supported

e. Performance Test Signal Paths: The signal paths for the above Performance Standards shall be as follows:
1) Audio: From any and all source inputs (for microphones, audiotape units, videotape units, etc.) through all audio processing, audio distribution amplifiers (ADA), mixers, switchers, codec, etc., to all electrical signal destinations.
2) Video: From all source inputs (for cameras, computers, videotape units, etc.) through all distribution amplifiers (VDA), processors, switchers, etc., to all signal destinations.

f. Remote Control Standards: As a minimum, the remote control system for each space shall be programmed to include the following:
1) Owner Logo on first page.
2) Automatic System Shutdown.
3) AM/ PM Clock Settings.
4) 50 % audio level default.
5) Separate Program and Microphone Audio Level Control with mute function.
6) Volume/ Mute control for program and speech audio reinforcement on every screen.
7) Panel layout to include user screens, as well as, password protected technician pages.
8) Raise and lower projection screen when projection is powered on/ off respectively.
9) Assign room computer as default system source upon power up.
10) Activate a minimum of three (3) presets for each installed remote controllable video camera.
11) Provide remote control room management software and full licensing for each system on the project.
12) Full function control of all source components, display units, processing devices and switching electronics.
13) In sub-dividable spaces, provide both IR and closed contact partition sensor control, and automation of control system scenerios.
14) Touch panel page layouts shall be submitted for approval. Prior to designing touch panel layouts, meet with the Owner and review existing control system standards on campus and determine a basis of design.

15) Follow-up programming and modifications as requested by the Owner shall be provided 6 months after system acceptance. Provide and install updated editable source code to the Owner following these updates.
16) In the event the remote control system programming becomes compromised during the warranty period, provide the necessary effort to make the system fully functional once again.

1.8 SUBMITTALS

A. Related Sections

1. Comply with requirements of Section 01 33 00 - Submittal Procedures.

B. Submittal Data

1. Submittal data is to be submitted in a three ring binder, a continuous spiral binder, or plastic binding that allows the booklet to lie flat while open. Each booklet shall contain the below in the following order:

a. Cover Sheet.
1) Include name of supplying contractor and project name.

b. Detailed Bill of Materials.
1) Include a listing of: component quantities, equipment manufacturers, model numbers, and description of each component being supplied, and the specification paragraph or drawing sheet that corresponds to the product. Failure to provide this information will result in the rejection of submittals.

c. Product Data.
1) Include a catalog sheet per product of equipment listed in the Detailed Bill of Materials, in the exact order as the Detailed Bill of Materials. Each catalog sheet shall describe mechanical, electrical and functional equipment specifications. The catalog sheet must also include an image of the product. Photocopy duplications of the manufacturer's original equipment catalog sheets will be allowed as long as they provide adequate clarity of both the printed word and graphics/pictures. If more than one product is shown on the catalog sheet the intended product must be denoted by either an arrow or highlight.

d. Authorized Distributor Certificate.
1) Recently dated (within one year from submittal date) support letter from manufacturer stating that the supplying contractor is an Authorized Distributor of the product being supplied.

C. Shop Drawings

1. Prior to fabrication submit contractor generated drawings for approval for all supplied systems. These drawings shall include, but are not limited to, the following:

a. Title Sheet & Symbols Legend

b. All panels, plates, and designation strips, including details relating to terminology, engraving, finish and color.
c. All equipment racks, cabinets, consoles, tables, carts, support bases, and shelves.
d. Schematic drawings (AV & Control Signal Flow), system functional block drawings, including those for audio and video subsystems. Resubmission of contract drawings is unacceptable.
e. All unusual equipment modifications.
f. Front mechanical drawings of each equipment rack.
g. Equipment location drawings.
h. Cable labeling plan.
i. Floor Plans, RCPs and Elevations: Show planned location for all elements and cable routing. Drawings should be at project standard scale and clearly legible.

D. Form

1. Submit all materials for review as described above, specifically referenced to the Specification paragraph number (where applicable).

a. Submit all drawings on sheets of one size, preferably the project standard size.
b. Where materials are presented on sheets 11” x 17” or smaller, organize into three-ring binder which include:
1) Dividers or tabs between logical sections
2) Project name and binder title labels on face and edge of binders

c. On submittal drawings, maintain 3/32” minimum lettering height. Submittals with text less than 1/16” in height may be rejected.

2. Partial Submittals may be rejected. If submitted individually and each in its entirety, the following Submittals shall not be considered partial:

a. Personnel
b. Milestones
c. Conduit Verification Statement and Notifications
d. Rigging and Mounting Drawings
e. As-Built Documentation

3. Product Data and Shop drawings must be submitted together in order to be reviewed.

E. User Interface

1. In order to develop a user interface which is both functional and useable, provide working “Beta” copies of system software for review and comment by the owner, architect and the AV consultant as per the below listed schedule:

a. This is anticipated to be an interactive process, requiring at least three submittals prior to first beneficial use. At a minimum, the software development process will have the following milestones:
1) Initial concept Submittal for Review
2) First Beta Review
3) Second Beta Review
4) Final Implementation and On-Site Training: Prior to Final Acceptance

5) Follow-up programming review and updates; Timing (within sixty-days from final acceptance)

F. Weekly Reporting

1. Commencing with project award, provide weekly status reporting of milestone task status, anticipated completion date, and related memo notes for the following tasks:

   a. Submittals
   b. Infrastructure verification
   c. Pre-wire status
   d. Equipment Procurement
   e. Shop fabrication
   f. Remote control system design
   g. Installation and Terminations
   h. Field testing and pre-acceptance testing
   i. Final acceptance demonstrations
   j. Owner training
   k. First owner use
   l. Open Coordination Items and Questions

2. See below for a partial example of an acceptable weekly reporting list.

Project:	*Project Name*			
Location:	*Project Location*		Date:	*Form Delivery Date*
Project Manager:	*Project Manager*		Delivered by:	*Form Delivered By*
		Projected Completion:	Status:	Notes:
Infrastructure Verification:		*6/1/2011*	*Complete*	
Submittals:				
	Product Data	*8/1/2011*	*Complete*	
	Drawings	*8/1/2011*	*Complete*	
	Personnel (etc.)	*8/1/2011*	*Complete*	
RFIs:				
	12	*8/25/2011*	*Received*	*Implementing*
	178	*9/6/2011*	*Pending*	*Projector Screen Clearances*

Installation Status by Space

Room			Equipment				
Name	Number	Pre-Wire	Order	Receive	Install	Test	Notes:
Example 1	*105*	*100%*	*100%*	*100%*	*60%*	*0%*	*Re-programming*
Example 2	*135*	*100%*	*100%*	*100%*	*90%*	*0%*	*Other Notes Here*

G. Personnel

1. Provide, in writing, within two weeks after award of Contract, the names, mailing address, phone numbers with extensions, email addresses and paging service numbers (if available) of the following project personnel:

    a. Project Manager
    b. Lead Systems Engineer
    c. Field Foreman
    d. Remote Control System Programmer

H. Conduit Verification

1. Within four weeks after award of Contract, submit statement confirming that Contractor has reviewed the conduit system as designed in building construction documents and, where applicable, as built.
2. Notify Consultant, General Contractor, Architect or Electrical Contractor of deficiencies or inadequacies, if any, in conduit system design or installation. If none, so indicate.
3. Absent conduit verification by Contractor and after installation of conduit as designed, Contractor shall assume costs of equipment, materials, labor and engineering, including services of owner's representative(s) in designing and/or verifying revised wiring approach(es) as relate to providing a fully functional system using conduit as designed or as revised at the discretion of the owner.

I. Rigging and Mounting Drawings

1. Submit full size drawings outlining mounting and installation details of all AV equipment requiring integration with cabinetry or architectural elements.
2. Details, stamped and signed by an appropriately licensed engineer, of all equipment mounting methods and materials provided by the Scope of Work, wherein failure of method or materials used for mounting or hanging permanently installed equipment could result in serious personal injury.

    a. Details provided by or requiring approval by licensed engineer may include: method of attachment to building structure or attachment and/or suspension points; method of attachment to supported equipment; all suspension materials; a materials list including specifications of all suspension materials; calculations used to determine loads and strengths of suspension materials, other as deemed necessary by the engineer.

3. In the absence of submitted approved, stamped and signed mounting and hanging details, the Owner reserves the right to acquire such engineering approval at the expense of the Contractor. Owner will notify Contractor of such intent. Contractor shall remedy within two weeks or Owner may proceed without Contractor approval and without relieving Contractor from any other obligations set forth by Contract.

J. Color Selection

1. Color options for all items as applicable.
2. Wallplate finishes should be coordinated with the Architect.

K. Samples

1. Color and finish samples of any furniture or lecterns.

1.9 CLOSEOUT SUBMITTALS

A. At the completion of the installation, but before Final Acceptance, provide for review and approval the following, in compliance with Division 1 Section *Closeout Procedures*.

1. Operation and Maintenance Manuals:

   a. Equipment manufacturer's operation and service manuals for each make and model of equipment.
   b. System Operation Manual. Produce a manual specifically for the subsystems detailed herein. The manual shall describe all procedures necessary to activate each system to provide for the functional requirements, except as specifically excluded by the Owner. This section shall provide a simple "How-to" users guide for the procedures needed to operate the system. This document shall contain a section on operating the systems equipment in the event of control system failure. Control system touch panel layouts shall be accompanied by narrative text describing "step-by-step" function engagement.

2. Warranty

   a. Provide list and dates of activation of equipment warranties
   b. Provide original manufacturers' certificates.

3. As-built Drawings

   a. Include contractor generated (mark-up of contract documents is not acceptable) digital record diagrams for all systems including, but not limited to:
      1) Schematic wiring diagrams with cable markings.
      2) Internal wiring diagrams of the equipment rack cabinets.
      3) Custom equipment modifications.
      4) Final test results and nominal settings for all adjustable controls.

4. Software Passwords

   a. Software Passwords Schedule (i.e., a spreadsheet listing the manufacturer, model number and location in the Facility, of each piece of audio/video equipment, the software for which is password-protected).
   b. Provide to Owner's Representative as a secure document separate from Operating and Maintenance Manuals and As-Built Drawings.

5. Editable Control System Code

   a. Provide the final control system code in an editable format.

6. Laminated Instruction Cards

a. Provide 8 ½ x 11 Instruction cards, approved by the Owner. Laminate step-by-step instructions outlining system operations for each room that has an AV system. Provide editable file of card to Owner.

1.10 DELIVERY, STORAGE, HANDLING, AND STAGING

A. Supply, transport, deliver, unload, move to the installation location, unpack, place, assemble, secure, connect, and install all equipment needed to complete the installation. Be responsible for transportation, parking, delivery, and on-site storage of the system's equipment. Be responsible for all transportation of personnel to and from the site.

B. Reconfirm before delivery that hallways, stairways, passages, doorways, rooms, entries, elevators and foyers are of sufficient size to accommodate the passage and installation of the equipment and systems. Off-site pre-staging of goods is encouraged.

C. The Owner's acknowledgment of delivery of goods and any payment made on account of such delivery shall not constitute acceptance (partial or otherwise) and shall not diminish obligations as specified.

D. The actual dates of delivery shall be under the absolute control of the Owner. The dates and times for delivery/installation are critical to the successful completion of the project. Deliveries shall normally be accepted only Monday through Friday 8:00 a.m. to 4:00 p.m. In the event it becomes necessary for goods to be installed outside these hours comply with the instructions of the Owner. Deliveries attempted outside these hours without prior consent of the Owner may be turned away. Comply with all instructions of the Owner and the Contractor concerning time of arrival at the site; which entrance shall be utilized for delivery; routes to be taken to reach the installation location; and other matters relating to the orderly and timely installation of the system.

E. Installation shall commence immediately upon delivery of materials to the jobsite, except as directed by Construction Manager. Time required from delivery date to completion of project shall be in accordance with the approved schedules.

1.11 SYSTEM TRAINING

A. Training: Provide training in the operation and maintenance of the system for personnel designated by the Owner. Record owner training sessions on DVD or other agreed upon media, and make training videos available to the owner at no charge. The training shall be organized as follows:

1. Two (2) two-hour training classes for system technical operation and maintenance. This class shall cover the following topics:

a. Review of signal flow diagrams.
b. Review of all equipment functions, relevant to the function in this system.
c. Review of initial equipment settings.
d. Demonstration of all functional connections from a user perspective.
e. Review & demonstration of replacement procedures for consumables (e.g., lamps).
f. Review of manufacturers' recommended routine maintenance procedures.

2. Two (2) two-hour training classes for system engineering concerns. This class shall cover the following topics:

    a. Review of signal flow diagrams.
    b. Review of all equipment functions, relevant to the installation.
    c. Review of initial equipment settings.
    d. Review of manufacturer's recommended routine maintenance procedures.
    e. Review & demonstration of replacement procedures for consumables (e.g., lamps).
    f. Review & demonstration of control system software replacement/upgrade procedures.

3. Two (2) four-hour training classes addressing AV system operations. The classes will demonstrate and describe the following:

    a. System set-up and operations.
    b. Control system operation.
    c. How to attach microphones, record AV signals, and control the sound system .
    d. Videoconferencing operation & capabilities (if applicable).
    e. Audio monitoring and ADA system operations.
    f. Cable antenna television system (CATV).

4. Training may take place at any time (chosen by the Owner) after the systems are operational, up to a year following system acceptance.
5. Close out submittals shall be provided prior to any training classes.
6. Coordinate detailed specifics of the training session(s) time, date & location with the Owner.

1.12 WARRANTY

A. The system warranty shall be for twenty-four (24) months from the date of final acceptance. Provide all equipment, material, and labor required to uphold a full system warranty at no charge to the Owner. All manufacturers' equipment warranties shall be activated in the Owner's name and shall commence on the date of final acceptance. In the case of modified equipment, the manufacturer's warranty is normally voided. In such cases, provide the Owner with a warranty equivalent to that of the original manufacturer.

B. There shall be no cost to the Owner for maintenance performed during the warranty period beyond the fixed cost of the contract.

C. Coordinate and provide updates to the control system code & touch panel layouts based on owner feedback of desired functionality during warranty period.

D. Provide a total of eight (8) one-day visits per year, or a total of sixty-four (64) engineering/ service labor hours to conduct preventive maintenance and the Owner directed system adjustments.

E. Each visit will include:

    1. Cleaning optical lenses.
    2. Checking and replacing projection lamps filters and indicators.

3. Checking and repairing microphones and microphone cables.
4. Conducting subjective and objective tests of the audio, video, and control systems of the installed audiovisual systems.

F. Repair and/or adjust any malfunctioning components located by the technician during this testing. Include control system programming updates and modifications as part of this service contract, providing an updated editable copy of the source code to the Owner.

G. Provide a service telephone number, staffed by a qualified technician familiar with the equipment installed. Staff this number during normal business hours.

H. Respond with an on-site technician within 24-hours of a service call (including Saturdays and Sundays) for all equipment and system failures.

I. Replace or repair, at no cost to the owner, any failed equipment hardware or software installations required to provide full system operations.

J. During the warranty period, advise the Owner in writing each time any routine software and firmware updates become available, giving the Owner the opportunity to upgrade the software/hardware should they so desire at no additional cost. Provide any necessary system modifications after installation of these updates to maintain a fully functioning system.

K. Provide updates to firmware during service period. Provide any necessary system modifications after installation of these updates to maintain a fully functioning system.

PART 2 - PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

A. Equipment Lists: Refer to the attachments following this Section for materials and equipment required to complete the work of this Section.

1) Ceiling Microphone

- Wide-range miniature condenser microphone with omnidirectional polar pattern
- 30 Hz – 20 kHz frequency response
- 250 ohm impedance
- 65 dB Signal to Noise Ratio

Product: Audio Technica ESS933/O or approved comparable product.

2) Ceiling Mounted PTZ Video Camera

- 1280 x 800 Video Resolution
- 30 FPS Frame Rate
- H.264 Network Video Streaming Capable
- Two-Way Audio Streaming

Product: Axis P3344 or approved comparable product.

3) DigitalMedia Reciever and Room Controller

- HDMI display output
- Supports 3D and Deep Color
- HDCP compliant
- Device control via CEC, RS-232, IR, or Ethernet

Product: Crestron DM-RMC-100-C or approved comparable product.

4) DigitalMedia Transmitter

- Multi-format DigitalMedia switcher and transmitter
- Transmits analog and digital audio and video over single 8G+ category cable
- RS-232 controllable
- 1 RU
- HDCP compliant

Product: Crestron DM-TX-201-C or approved comparable product.

5) DigitalMedia Presentation System

- Complete presentation control and signal routing processor
- Separate audio and video switching
- Two (2) HDCP Compliant HDMI inputs
- Three (3) HDMI or RGBHV video inputs
- Digital Media and HDMI outputs

Product: Crestron DMPS-300-C or approved comparable product.

6) 9” Lectern Mounted Control Touch Panel

- 9.4” active matrix touch screen display
- 800 x 600 SVGA display resolution
- 80 ft omni-directional RF range
- USB port for keyboard/mouse

Product: Crestron TMPC-9L or approved comparable product.

7) High-Definition Capture Recorder

- RGBHV, HDMI, and Component/HD-SDI Video inputs with audio
- Single 10/100/1000 Mbps auto-switching full/half duplex DHCP Ethernet connection
- Capable of live streaming and MMC file storage
- RS-232 Controllable
- 1 RU
- HDCP Compliant

Product: Crestron Capture HD or approved comparable product.

8) Ceiling Microphone

- Pressure Zone Microphone
- 80 Hz to 20 kHz Frequency Range
- Hemispherical polar pattern
- 68 dB Signal-to-Noise Ratio
- Low-Profile ceiling mounted microphone

Product: Crown PZM-10 or approved comparable product.

9) Tabletop Microphone

- Programmable on/off membrane switch
- Half-supercardioid polar pattern
- Balanced XLR output
- 50 Hz to 20 kHz Frequency Range
- 72 dB Signal to Noise Ratio

Product: Crown PCC-170SW or approved comparable product.

10) Digital Document Camera

- 16x Optical Zoom
- Supports XGA, WXGA, and SXGA video output
- DVI output
- RS-232 controllable

Product: Elmo P10 XGA or approved comparable product.

11) 4000 Lumen LCD Data/Video Projector

- 4000 ANSI Lumen output
- Supports up to 16:10 aspect ratio
- 2000:1 Contrast Ratio
- HDCP Compliant HDMI input
- Provide spare lamp for each projector
- Provide Epson projector ceiling mount

Product: Epson PowerLite Pro G5450WUNL or approved comparable product.

12) Surface-Mounted Cable Enclosure

- Low profile with tilt-up lid
- Flush-mountable
- Include architectural adapter plates (AAP) as needed
- Provide data and power connections at all enclosures

Product: Extron Cable Cubby 300c or approved comparable product.

13) USB 2.0 Extender

- Supports USB 2.0 at distances up to 330 feet

- Supports full 480 Mbps communication
- Transmits signals over Cat5, Cat5e,or Cat6 cable

Product: Gefen EXT-USB2.0-LR or approved comparable product.

14) Dual Channel 70V Amplifier

- 1RU
- 400 Watts at 4 Ohms
- 20 Hz to 20 kHz Frequency Response, +/- 0.2 dB
- 70 Volt audio output

Product: Lab Gruppen E 8:2 or approved comparable product.

15) USB 2.0 Web Camera

- USB2.0 Connectivity
- 2-Megapixel Resolution
- Provide Logitech 9-inch stand
- Provide USB Extender as needed

Product: Logitech QuickCam AF or approved comparable product.

16) Simulation Capture Console (OFE)

- Provide one (1) Axis Q7401 H.264 Single-Channel Video Encoder or Axis Q7404 Quad-Channel Video Encoder per Simulation Bay, to Encode Mannequin Vitals Video Feed for Network Distribution
- Provide MetiVision Console simulation capture consoles as needed
- Provide Network-Based Simulation Recording and Management Software Package
- Provide Network Accessible Storage Server for Recorded Simulation Content, Capable of Storing One-Thousand (1,000) Hours of Video Content
- Provide Scheduling and Management Software Modules, as needed
- Provide Seat Licenses, One (1) per Simulation Bay

Product: Metivision Console or approved comparable product.

17) Furniture Mounted Equipment Rack

- 10 useable rack spaces
- 18” deep equipment rack
- Provide security screws
- Provide quiet exhaust fan top 4”
- Provide RSH series rack mount kits as needed
- Provide rack mount UPS to support a minimum of 30 min. backup time
- Provdie Furman PL-Pro DMC power distribution
- Integrate into Control Room millwork, refer to architectural drawings

Product: Middle Atlantic CFR-10-18 or approved comparable product.

18) 65” Flap Panel Display w/ Integral Loudspeakers

- 65” screen size
- 1920x1080 resolution
- 16:9 aspect ratio
- 5,000,000:1 contrast ratio
- HDMI, DVI, Video, Component/RGB, PC, and Audio inputs
- Plasma display

Product: Panasonic TH-65PF30U or approved comparable product.

19) 5.25” 2-Way Loudspeaker

- Two-way loudspeaker with ported enclosure
- 63 Hz – 20 kHz frequency range, +/- 3 dB
- 8 ohms nominal impedance
- 87.5 dB Sensitivity
- 100 degree conical pattern

Product: QSC AD-CI52ST or approved comparable product.

20) 70” Interactive Annotative LCD Display

- 70” screen size
- 1920x1080 native display resolution
- 4000:1 contrast ratio
- 16:9 aspect ratio

Product: Sharp PN-E702 or approved comparable product.

21) Gooseneck Microphone

- 12” gooseneck electret condenser microphone
- Cardioid cartridge
- Frequency response: 50 Hz to 17 kHz
- Shock mount, flange mount, wind screen
- Mute switch and LED

Product: Shure MC412S/C or approved comparable product.

22) 18” Digital Annotation Device

- HDCP Compliant Digital Annotation Tablet
- A-Si TFT active-matrix LCD display
- Native 16:9 aspect ratio, supports 16:10 with scaling
- 580:1 Contrast Ratio
- DVI-I video input and output interfaces

Product: SMART SP518 or approved comparable product.

23) PTZ Video Camera

- ¼-type EXview HAD CCD imaging device
- 18x Zoom
- Y/C NTSC Video Output
- 50 dB Signal-To-Noise Ratio
- RS-232 Controllable

Product: Sony EVI-D70 or approved comparable product.

24) Blu-Ray Disk Player

- DVD+/-RW Playback
- CD, CD-R/-RW Playback
- Provide rack mount
- 3D and Deep Color playback supported
- 1080/24p Playback
- HDMI/Composite/Component outputs

Product: Sony BDP-S580 or approved comparable product.

25) Ceiling Mounted Document Camera

- Progressive scan 1/3” CCD, RGB
- Native SXGA signal output (1280 x 960)
- 30 frames/second
- Provide Ceiling Tile Bridge w/trim ring

Product: Wolfvision EYE-12 or approved comparable product.

PART 3 - EXECUTION

3.1 INSTALLATION

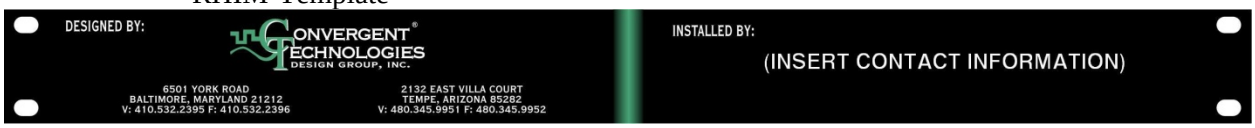
A. General:

1. All installation work shall be in accordance with, but not limited to, this specification and drawings. Work practices shall be performed in accordance with applicable standards, requirements, and recommendations of Federal and Local authorities having jurisdiction.
2. All discrepancies discovered and any discrepancies which are apparent at the date of submission of bids, shall be immediately corrected without additional charge to the Owner.
3. Clearly label all user controls for intended use and nominal setting. These labels shall be engraved and filled, or equal. Note: “Dymo” labels are not acceptable.
4. All equipment to be rack mounted shall be supplied with the appropriate rack mount kits.
5. Each rack enclosure shall have a single button on/off power distribution panel to include pull out lights and LED voltage indicator (Furman PL-Pro DMC or equal) located in the first available rack unit.

6. All equipment racks to include removable, locking front doors and a 4" diameter, low-noise fan.
7. All rack and instructor stations shall include "security type" screws to secure rack-mounted components.
8. In rooms containing wireless microphones or assisted listening system, provide an antenna distribution system inclusive of remote antennas as needed to support transparent coverage throughout the space(s).
9. In rooms containing auto tracking camera systems, provide one (1) day of manufacturers set up and programming.

B. Physical Installation:

1. Provide system identification plate as shown below. Plate shall occupy the first available rack unit in all AV equipment racks. If more than two (2) racks are positioned together, one (1) plate for every two racks is acceptable. Product: Liberty Cable # C2121-28046-RHIM-Template



2. All equipment shall be firmly secured in place unless requirements of portability dictate otherwise. Unless granted specific permission by the Owner, install and secure all boxes, equipment, etc., plumb and square.
3. Fastenings, mounting brackets and supports shall be adequate to support their loads with a safety factor of at least five (5). A safety chain or cable will be tied to all equipment suspended from above.
4. In the installation of equipment and cable, consideration shall be given not only to operational efficiency, but also to overall aesthetic factors.

3.2 AUDIOVISUAL CABLE INSTALLATION

A. All cables, regardless of length, shall be marked with wraparound cable markers at both ends. There shall be no unmarked cables at any place in the system. Marking codes used on cables shall correspond to codes shown on "as-built" drawings and/or run sheets. The labeling and numbering system will be coordinated with the Owner.

B. All wired microphones shall include a 30ft. patch cable with heavy-duty jacket and XLR connectors.

C. Loudspeakers operating at 8 ohms shall be installed with 12AWG cable as a minimum size/ diameter.

D. Wall plate and floor box input/output panels shall be installed with audio/ video line drivers on runs exceeding 35ft.

E. All cabling shall be neatly strapped, dressed, and adequately supported. Any exposed cabling shall be neatly enclosed in a protective covering.

F. Terminal blocks, boards, strips, or connectors shall be furnished for all cables, which interface, with racks, cabinets, consoles, or equipment modules.

G. All audio signal lines shall be balanced at AV I/O plates. Provide ninety (90) degree connector adapters for all AV cabling at custom AV I/O plates.

H. All cables shall be grouped according to the signals being carried. In order to reduce signal contamination, separate groups shall be formed for the following cables:

1. Power cables
2. RGBHV, Video cables and Control cables
3. Data cables (when applicable)
4. Audio cables carrying low level signals
5. Audio cables carrying line and high level signals

I. Supply cables as required to meet system performance standards. Any cabling installed in walls or ceilings shall be plenum rated. All cables shall be cut to the length dictated by the run plus the required service loop to permit future equipment movement and relocation. For equipment mounted in drawers or on slides, the interconnecting cables shall be provided with a service loop of appropriate length.

J. No cable shall be installed with a bend radius less than that recommended by the cable manufacturer. Notify the construction manager in the event that a field condition interferes with the proper installation of any cables or equipment.

K. Grounding Procedures: In order to minimize problems resulting from improper grounding and to achieve maximum signal-to-noise ratios, the following grounding procedures shall be adhered to:

1. General: Because of the great number of possible variations in grounding systems, follow good engineering practice, as specified herein, and to deviate from these practices only when necessary to minimize crosstalk and to maximize signal-to-noise ratios in the audio, video, and control systems. Inform the Consultant in the event that there is a deviation from the standard grounding practices prior to actually performing the work.
2. System Ground: A single “system ground” shall be established for the system. All grounding conductors shall connect to this system ground. The system ground shall be provided in the equipment rack, and shall consist of a copper bar of sufficient size to accommodate all secondary ground conductors.
3. A copper conductor, having a maximum of 0.1 Ohms total resistance, shall connect the system ground bar to the nearest grounded, metallic electrical conduit of at least 2 inches in diameter. Be responsible for determining if the metallic conduit is properly electrically bonded to the building ground system, and shall show the grounding path of a document that is provided with the system documentation.
4. Secondary system grounding conductors shall be provided from all ungrounded equipment in each area, to the primary system grounding point for the area. Each of these grounding conductors shall have a maximum of 0.1 Ohms total resistance.
5. Under no conditions shall the AC neutral conductor, either in the power panel or in a receptacle outlet, be used for a system ground.

L. Audio Cable Shields: All balanced audio cable shields shall be grounded at one point only. For ungrounded portable equipment, such as microphones, the shield shall be connected at both ends but grounded at only one end.

M. Video Receptacles: All video receptacles shall be insulated from the mounting panel, outlet box, or wire way.

N. Non-continuous cable supports

1. Audiovisual cables shall be supported AFC with adjustable non-continuous cable supports.
2. Non-continuous cable supports shall provide a bearing surface of sufficient width to comply with required bend radii of audiovisual cables.
3. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.
4. Installation and configuration shall conform to the requirements of the current revision levels of ANSI/ EIA/TIA Standards 568 & 569, NFPA 70 (National Electrical Code), applicable local codes, and to the manufacturer's installation instructions.
5. Do not exceed load ratings specified by manufacturer.
6. Follow manufacturer's recommendations for allowable fill capacity for each size non-continuous cable support.
7. Non-continuous cable supports shall be ERICO CableCatTM J-hook series or approved equal.

3.3 REPAIR/RESTORATION

A. Any damage to any installed work or product caused by the unpacking, transporting, assembly, connecting, or configuring of the product shall be repaired at no charge to the Owner.

3.4 FIELD QUALITY CONTROL

A. Once installed and the System Checkout is complete, the system shall be demonstrated as operational to the Owner.

1. If the AV system fails to meet the requirements of this document or those stated by the technical documentation, then the Owner shall reject the installed system and the contractor shall be given notice (either oral or in writing) to correct the failure.
2. If unable to overcome repeated performance deficiencies within thirty (30) days, and if requested to do so by the Owner, remove the equipment and replace at no expense to the Owner.
3. No warranties shall begin until the Owner has authorized final acceptance in writing.
4. Right to Revoke Acceptance: If any equipment and/or goods which have been previously accepted, specifically or by the making of payment, are found to have defects, damage, deficiencies, or fail to conform to the specification, for any cause not attributable to the Owner, the Owner may revoke acceptance.

B. Conduct pre-acceptance tests

1. Perform all system performance checks on the installed systems prior to final acceptance testing. The Owner / AV Consultant, may witness the pre-acceptance tests. The Owner / Architect may inspect and operate system components in order to evaluate installation progress and technical compliance prior to acceptance testing.

C. Contractor System Checkout

1. Perform system checkout before acceptance tests are scheduled. Furnish all required test equipment. Perform all work necessary to determine and/or modify performance of the system to meet the requirements of this specification.
2. During performance testing, all equipment shall be operated under standard conditions as recommended by the manufacture.
3. Test all audio and video systems for compliance with the Performance Standards using test procedures that follow later in this specification.
4. Maintain documentation of all performance tests for reference by Consultant during the System Acceptance Tests.
5. At the conclusion of the tests, return all equipment settings to previously calibrated positions.
6. Provide written records of all test results in spreadsheet form.
7. Check all control functions, from all controlling devices to all controlled devices, for proper operation.
8. Adjust, balance, and align all equipment for optimum quality and to meet the manufacturer's published specifications. Establish and mark normal settings for all level controls, and record these settings in the "System Operation and Maintenance Manual."
9. Provide testing results and settings for all equipment and systems to the AV Consultant at least three (3) business days prior to System Acceptance Testing.
10. Provide the AV Consultant with all test results, manuals, software, as-built documentation, etc. prior to acceptance testing.
11. Inform the Owner and AV Consultant that the systems are ready for System Acceptance Testing by the AV Consultant. The system shall be considered ready for acceptance testing when the following conditions are met:

    a. AV Contractor has pre-tested all systems such that all sub-systems, functions, software, and equipment are de-bugged and operational
    b. AV Contractor has supplied the AV Consultant with the written test results and documentation as listed above for all rooms and systems
    c. AV Contractor has supplied the AV Consultant with close out (manuals, training materials, and other as-built) documentation revised to reflect comments and/or revisions arising from the review cycles listed elsewhere within this document

12. Should the systems not be ready for testing by the AV Consultant at the date(s) and time(s) indicated by the AV Contractor, system acceptance testing may be rescheduled at the sole discretion of the AV Consultant. The AV Contractor shall pay for the labor and expenses of the AV Consultant and other project team members assembled at the project site for the purpose of system acceptance testing for the date(s) of the original scheduled testing plus the labor and expenses of the AV Consultant and other project team members for the rescheduled testing date(s). The labor rate for the AV Consultant shall be a flat rate of $200.00/hour including travel time. Other project team member labor costs shall be at their respective published rates. The PM and/or Owner shall be entitled to deduct any money owed to the Owner, PM, AV Consultant, or other project team members under this contract from any sum which may become due or is payable to the AV Contractor under this Contract for the purposes of satisfying the charges listed above.

D. Final Acceptance Test

1. Testing will be performed with the Owner (or its designees) present to determine that the AV system equipment satisfies the manufacturers' performance specifications and that the AV system installed satisfactorily performs the functions required by this specification. Conduct formal pre-acceptance tests prior to the Owner's acceptance testing to ensure that the performance and functional specifications are satisfied by the installed system and the system is ready for the Owner's acceptance. The AV contractor shall verify in the owner's presence that the installed audiovisual system satisfies the performance and functional requirements through formal acceptance testing. The AV contractor shall be responsible for staging each room to be tested, and shall have sufficient personnel on site to run multiple systems at once (not less than three (3) personnel).

E. Test Equipment

1. Assemble the following test equipment (or equivalent) on site.

   a. Video signal generator, Leader 410C
   b. Combined waveform monitor/vectorscope, Leader 5872A
   c. Prerecorded VHS tape (NTSC)
   d. RGB HV cable, Extron BNC-5-6'HR
   e. Audio and Video cable, terminations, adapters, etc
   f. Audio Test CD
   g. DVD
   h. Programmable Video & Audio Test Generator, Extron VTG-400D
   i. HDMI/DVI Test Signal Generator

F. Audio System Testing

1. Absolute Impedances

   a. Set any speaker level controls at zero attenuation. Measure absolute impedance value of each speaker line at 250, 500, 1000, 2000, 4000 Hz without the amplifier connected but with all speakers connected. Impedance must not be below the rated load impedance of respective amplifier and may be any value equal to or above that. Check resistance of lines to all speakers and microphone receptacles with receptacles open and short-circuited.

2. Hum and Noise Level

   a. Test overall hum and noise, it should be at least 60 dB below rated power output of each amplifier with amplifier controls set for optimum signal to noise and full output and with inputs terminated with proper shielded resistor. (150 and 600 ohms).

3. Parasitic Oscillation and RF Pickup

   a. Set up system for each specified mode of operation.
   b. Use 5 MHZ band with oscilloscope and speaker monitoring.
   c. Check to insure that the system is free of spurious oscillation and RF pickup in the absence of any input signal and also with the system driven momentarily to full output at 160 Hz.

4. Buzzes, Rattles, Distortions

    a. Apply high quality music signal to the system. Adjust the sound system for frequent peaks at its specified maximum sound pressure level.
    b. Apply sine-wave sweep from 50 to 5,000 Hz to 6 dB below full amplifier power.
    c. In both cases, listen carefully for buzzes, rattles and objectionable distortion.
    d. Correct all causes of such defects. If cause is not from system, promptly notify the architect indicating cause and suggested corrective procedures.

5. Equalize all audio systems for maximum gain before feedback in all room configurations.
6. Record all systems settings and include into Systems Operation manuals

G. Video System Testing

1. Signal Paths

    a. Utilizing a NTSC color bar generator and waveform analyzer with the video signal set at 100% saturation and 75% amplitude check that the video performance specifications are met at the display devices from all source inputs to all system outputs. Connect the combined waveform monitor/vectorscope to a final output point, e.g. an input to a picture monitor or video projector. Ensure that the test signal is routed to the selected output.

2. Level Balance

    a. Adjust all video projection equipment to produce the best image possible. Ensure that horizontal sweep circuitry is not over driven to the point of audible sweep frequencies being emitted.
    b. Adjust all video monitor and videocassette players, video sources to produce the best image possible.
    c. Record all systems settings for inclusion into systems manuals

H. RGBHV System Testing

1. For all RGBHV inputs, connect the RGBHV output of the signal generator to a floorbox/table/rack connector and select the SMPTE bar with “pluge pulse” signal at the following computer scan rates:

    a. 1024 x 768 XGA
    b. 1280 x 1024 SXGA
    c. 1366 x 768 WXGA
    d. 1400 x 1050 SXGA+
    e. 1440 x 900 WXGA+
    f. 1600 x 1200 UXGA
    g. 1900 x 1080
    h. 1080i
    i. 1080p
    j. 720i
    k. 720p

2. Check that the image is correctly displayed at all system outputs including the monitor(s) and/or by the video projector.
3. Repeat items 1 and 2 using Crosshatch, Checkerboard, and H Pattern Signals

I. Digital Video System Testing

1. For all digital video inputs, connect the output of the digital signal generator to each connection at the following resolutions:

a.	640 x 480p60	24 MHz Pixel Clock
b.	1024 x 768p60	63.5 MHz Pixel Clock
c.	1280 x 768p60	68 MHz Pixel Clock
d.	1280 x 768p60	79.5 MHz Pixel Clock
e.	1280 x 1024p60	109 MHz Pixel Clock
f.	1920 x 1080p60 (SMPTE reduced)	148.5 MHz Pixel Clock
g.	1920 x 1200p60 (blanking reduced)	154 MHz Pixel Clock
h.	1600 x 1200p60	162 MHz Pixel Clock
i.	1920 x 1080p60 (VESA)	173 MHz Pixel Clock
j.	1920 x 1080p60 (SMPTE rd.) Deep Color	148.5 MHz Pixel Clock
k.	1280 x 768p60 3D HDTV	
l.	1920 x 1080p24 3D HDTV	
m.	1920 x 1200p75 Deep Color	
n.	2560 x 1600p75	
o.	4096 x 2160p24	
p.	4096 x 2160p24 Deep Color	

2. Check that the image is correctly displayed at all system outputs including the monitor(s) and/or by the video projector. Display resolution shall be limited only by the manufacturer specified capabilities of the display or source device.
3. Repeat items 1 and 2 with an HDCP compliant source to all outputs simultaneously to verify compliance.

J. Optical Projection Systems

1. All optical projection systems shall meet the following performance standards:

   a. The total averaged light output from a projector, in lumens, shall be within plus-or-minus 15% of that specified by the projector manufacturer.
   b. The light fall-off from the center of the projected image to all four corners, as measured at the projected image plane, shall not exceed 35% for slide projector images. The light intensity shall be measured at all five positions of the projected image after the projector has been adjusted to provide the light output as specified above.
   c. The “corner” locations shall be defined as the four points determined by intersecting lines drawn 5% of the distance in from the focused edges of the image.
   d. The light meter used for the above measurements shall be properly calibrated footcandle (or lux) meter and shall be cosine-corrected
   e. Projectors, lenses, and mirrors shall be solidly mounted and braced so that there will be no observable movement in the image induced by motor vibration or other mechanical operations.

K. Qualification Methods

1. Three methods will be used to qualify the AV system for acceptance.

   a. Inspection - A critical observation of qualifying factors, such as quality of workmanship, equipment placement, routing of cables, adequacy of technical documentation, etc., that do not lend themselves to demonstration or measurement.
   b. Demonstration - A process of showing by reason or evidence that a given condition clearly satisfies the requirement.
   c. Measurement - A process of determining the actual dimension, capacity, or amount of something, by measuring using calibrated standards.

2. Acceptance of the Work of this Section shall occur after completion of corrections and adjustments required by "Punch List" (as generated during Demonstration and Acceptance Testing of Completed Installation).
3. Owner reserves the right to use equipment, material and services provided as part of Work of this Section, prior to Acceptance, without incurring any obligation to Accept any equipment or completed systems until Punch List work is complete and systems comply with Contract Documents.

3.5 SCHEDULES

A. Teaching Laboratories (C148, C150, C154, C156)

1. General: The Teaching Laboratories will be used primarily for classroom instruction and medical simulation with expandable recording capability. Classroom instruction will utilize an instructor's station at the front of the classroom, which will house several sources and be able to interface with a wall-mounted interactive flat panel display. Every two (2) teaching laboratories will be served by a single Control Room, which will house central switching and signal processing hardware to serve both Teaching Laboratories.
2. The video display system will consist of a single, large-format wall mounted interactive flat panel display. This flat panel display will offer full annotation and touch interactive capability. An Instructors Station will be located at the front of the classroom, and will house several AV system sources as well as a 9" color remote control touch panel. From these touch panels, users will have intuitive control over all AV system functions. An additional remote control touch panel will be located in the Control Room. Above each lectern shall be a ceiling-mounted document camera, to provide a view of the lectern work surface. All lectern-mounted devices will be routed through a central AV switcher in the Control Room, which will distribute video to each interactive flat panel display. A speech/program audio reinforcement system will be provided, to consist of ceiling-mounted loudspeakers. All equipment located in the Control Room shall be mounted in furniture-mounted equipment racks, to consist of two side-by-side 10RU equipment racks in the center of the control room work area millwork. A custom floorbox will be provided for cabling and connections from the Instructor's Station. Medical simulations will be recorded through USB cameras connected to student or faculty-furnished laptops. Infrastructure will be provided at two (2) bed locations in each laboratory for future video camera and microphones to be used in medical simulation recording.
3. System Interconnection: The functional interconnections of the RGBHV, video, audio, and control systems shall be as detailed on the "TA" series drawing sheets associated with this space.

4. Equipment Layout: The equipment in this area shall be located as detailed on the "TA" series drawing sheets associated with this space.
5. Owner Furnished Equipment (OFE): Personal/Laptop Computer, Instructors Station
6. System Details

    a. Control System: The Control System will be controlled from a hardwired lectern mount color LCD touchscreen that shall terminate at the specified custom instructor's station. An additional touch screen will be located in the Control Room. From this touchscreen, users shall have full function control of all room source and system functions with one button operation. These sources and associated electronics are to be detailed in the control drawing associated with these rooms. Touchscreen layouts to be approved prior to installation. It is intended to have the control system programmed to turn power on/off for all system components with a single function button.
    b. Electrical Boxes and Conduit: Electrical Contractor to provide electrical boxes and conduit below the floor, in the walls, and above the ceiling. Be responsible for all custom AV plates and the necessary cabling connecting to the system's equipment. There shall be a custom floorbox location for input/output hook-ups during presentations. Confirm on site conditions prior to ordering.
    c. Program/Speech Reinforcement Loudspeakers: Ceiling-mounted loudspeakers will be installed for monaural speech and stereo program audio signals. Take care not to damage the ceiling during installation, and repair or replace any damage caused during the installation. Audio inputs include, but are not limited to: personal computers, Blu-Ray Disk Player, Host PC Computer, and microphones.
    d. LCD Display: The LCD display shall be installed as detailed on the AV drawings.
    e. Video Cameras: Provide USB Web Cameras for use in recording medical simulations on student-furnished laptops.
    f. Instructor's Station: This station is to be located at the front the room. At this position, the station will have AV patch points via an associated room floorbox for connection to the room' system.
        1) The specified instructor's stations will house the following: remote control touchscreen, keyboard/mouse, and laptop input connections.
        2) The station will be equipped with a task light. Unit to include a single duplex AC power receptacle on the work surface. Laptop access shall be provided.

    g. Equipment Rack/Hardware: Provide rack and all equipment rack hardware, including vent panels, slide-out shelves, rack mounts and miscellaneous hardware for a complete and finished system. The equipment rack for this room shall be located as detailed on the AV series drawings. Provide cable management from the rack to associated wall plate.

7. Equipment List: Included in Part 2 of this Section is a consolidated equipment list which includes all equipment for this space. Each of these items shall be priced using both the equipment make and model shown, or components with equivalent functionality and of newer make, which meet or exceed the performance characteristics that are outlined for each component in the list. If an item is listed as "Custom," this means that the Contractor may use any manufacturer's component appropriate for the function and quality required for that item. Submit a "build" quality shop drawing for approval, on any custom items.

B. Clinical Simulation Laboratories (C144, C146)

1. General: The Clinical Simulation Laboratories will be used for medical simulation with recording capability, which will enable instructors to conduct student examinations with the opportunity to review the student's performance at a later time. Both laboratories will be connected to a single Control Room which will house all central switching, processing, and recording hardware. Microphones and cameras will be provided at each bed location to enable simulation recording.
2. Each simulation laboratory will feature two bed locations, and each bed location will feature two ceiling mounted video cameras and one ceiling mounted microphone. Each microphone will interface with one of the associated video cameras, which will encode AV signals to network-based distribution, and will be routed directly to one of two dedicated simulation recorder consoles. Two host PC computers will be located in the Control Room, which can be used to play back recorded simulation content. Blu-Ray disk players will also be included in the Control Room, which will provide content for ceiling-mounted flat panel displays located in each Simulation Laboratory. An in-room host PC will also be included in each Simulation Lab, which will provide simulated charting and medical information to the flat panel display. A color remote control touch panel will be included in the Control Room to provide operators with intuitive control over all AV system functions. A speech/program audio system will be provided to consist of ceiling-mounted loudspeakers. All equipment located in the Control Room will be mounted in furniture-mounted equipment racks to be integrated into the work area millwork.
3. System Interconnection: The functional interconnections of the RGBHV, video, audio, and control systems shall be as detailed on the "TA" series drawing sheets associated with this space.
4. Equipment Layout: The equipment in this area shall be located as detailed on the "TA" series drawing sheets associated with this space.
5. Owner Furnished Equipment (OFE): Personal/Laptop Computer
6. System Details

    a. Control System: The Control System will be controlled from a hardwired color LCD touchscreen that shall terminate at the specified equipment rack. An additional touch screen will be located in the Control Room. From this touchscreen, users shall have full function control of all room source and system functions with one button operation. These sources and associated electronics are to be detailed in the control drawing associated with these rooms. Touchscreen layouts to be approved prior to installation. It is intended to have the control system programmed to turn power on/off for all system components with a single function button.
    b. Electrical Boxes and Conduit: Electrical Contractor to provide electrical boxes and conduit below the floor, in the walls, and above the ceiling. Be responsible for all custom AV plates and the necessary cabling connecting to the system's equipment. Confirm on site conditions prior to ordering.
    c. Program/Speech Reinforcement Loudspeakers: Ceiling-mounted loudspeakers will be installed for monaural speech and stereo program audio signals. Take care not to damage the ceiling during installation, and repair or replace any damage caused during the installation. Audio inputs include, but are not limited to: personal computers, Blu-Ray disk player, along with wireless microphones.
    d. LCD Display: The LCD display shall be installed as detailed on the AV drawings.

e. Video Cameras: Wall mounted video cameras shall be provided at the front and back of the room as detailed on the AV drawings.
f. Equipment Rack/Hardware: Provide rack and all equipment rack hardware, including vent panels, slide-out shelves, rack mounts and miscellaneous hardware for a complete and finished system. The equipment rack for this room shall be located as detailed on the AV series drawings. Provide cable management from the rack to associated wall plate.

7. Equipment List: Included in Part 2 of this Section is a consolidated equipment list which includes all equipment for this space. Each of these items shall be priced using both the equipment make and model shown, or components with equivalent functionality and of newer make, which meet or exceed the performance characteristics that are outlined for each component in the list. If an item is listed as "Custom," this means that the Contractor may use any manufacturer's component appropriate for the function and quality required for that item. Submit a "build" quality shop drawing for approval, on any custom items.

C. Practice Laboratory (C157)

1. General: The Practice Laboratory will be used as an area for simulation debriefing, and limited student-use presentation and content sharing. No medical simulation will occur in these spaces, and no recording hardware will be provided.
2. The video display system will consist of a single, large-format wall mounted flat panel display with integral loudspeakers which will be used to display content from student or faculty laptops. A 5-gang AV input wall plate will be provided adjacent to the display for video and audio input connections. Control over the flat panel display functions will be available to users through direct interfacing with the flat panel display control buttons.
3. System Interconnection: The functional interconnections of the RGBHV, video, audio, and control systems shall be as detailed on the "TA" series drawing sheets associated with this space.
4. Equipment Layout: The equipment in this area shall be located as detailed on the "TA" series drawing sheets associated with this space.
5. Owner Furnished Equipment (OFE): Personal/Laptop Computer
6. System Details

a. Control System: Control over flat panel display functions will be available through direct interfacing with panel buttons.
b. Electrical Boxes and Conduit: Electrical Contractor to provide electrical boxes and conduit below the floor, in the walls, and above the ceiling. Be responsible for all custom AV plates and the necessary cabling connecting to the system's equipment. There shall be a custom floorbox and rackplate location for input/output hook-ups during presentations. Confirm on site conditions prior to ordering.
c. LCD Display: The LCD display shall be installed as detailed on the AV drawings.

Equipment List: Included in Part 2 of this Section is a consolidated equipment list which includes all equipment for this space. Each of these items shall be priced using both the equipment make and model shown, or components with equivalent functionality and of newer make, which meet or exceed the performance characteristics that are outlined for each component in the list. If an item is listed as "Custom," this means that the Contractor may use any manufacturer's component appropriate for the function and

quality required for that item. Submit a "build" quality shop drawing for approval, on any custom items.

D. General Classrooms (C123, C124, C125, C217, C218, C219, C223, C224, C226, C227, C232, C233, C235, C236)

1. General: The General Classrooms will utilize audiovisual presentation technology to enhance instructional presentations. An instructors station will be provided at the front of each classroom, which will house all AV system sources and components. A video projection system will be provided, along with a speech/program audio reinforcement system. A custom floorbox will be provided at the instructor's station location for cabling connections.
2. The projections system will consist of a single ceiling-mounted video projector, which will display images onto a ceiling mounted electrically retractable projection screen located at the front of each classroom. A separate speech/program audio reinforcement system will be provided to consist of a distributed array of ceiling mounted loudspeakers. AV sources to be housed in the instructor's station shall include a document camera, Host PC with digital annotation tablet, and gooseneck microphone. AV inputs will be provided for user-furnished laptop computers. A remote control touch panel will be provided for full control over all AV system functionalities. An AV recording/streaming appliance will be provided at the Instructors Station which will be capable of recording and streaming AV content generated during instructional presentations. A wall-mounted video camera will be installed at the rear wall of each classroom, along with a ceiling-mounted omnidirectional microphone, which will interface with the recording/streaming appliance for full lecture capture functionality.
3. System Interconnection: The functional interconnections of the RGBHV, video, audio, and control systems shall be as detailed on the "TA" series drawing sheets associated with this space.
4. Equipment Layout: The equipment in this area shall be located as detailed on the "TA" series drawing sheets associated with this space.
5. Owner Furnished Equipment (OFE): Personal/Laptop Computer, Instructors Station
6. System Details

    a. Control System: The Control System will be controlled from a hardwired lectern mount color LCD touchscreen that shall terminate at the specified custom instructor's station. An additional touch screen will be located in the Control Room. From this touchscreen, users shall have full function control of all room source and system functions with one button operation. These sources and associated electronics are to be detailed in the control drawing associated with these rooms. Touchscreen layouts to be approved prior to installation. It is intended to have the control system programmed to turn power on/off for all system components with a single function button.
    b. Projection Screen: The projection screen will be provided and installed by the Construction Manager. Projection screen shall be either electric operated "permanently tensioned" type controlled by the remote control system.
    c. Electrical Boxes and Conduit: Electrical Contractor to provide electrical boxes and conduit below the floor, in the walls, and above the ceiling. Be responsible for all custom AV plates and the necessary cabling connecting to the system's equipment. There shall be a custom floorbox and rackplate location for

input/output hook-ups during presentations. Confirm on site conditions prior to ordering.

d. Program/Speech Reinforcement Loudspeakers: Ceiling-mounted loudspeakers will be installed for monaural speech and stereo program audio signals. Take care not to damage the ceiling during installation, and repair or replace any damage caused during the installation. Audio inputs include, but are not limited to: personal computers, along with wireless microphones.

e. Data/Video Projector: The data/video projector shall be installed on the ceiling of the General Classroom. The video projector shall be installed and adjusted to produce an image that fills the projection screen. Install on fixed pole mount secured to building structure.

f. Video Cameras: Wall mounted video cameras shall be provided at the front and back of the room as detailed on the AV drawings.

g. Instructor's Station: This station is to be located at the front the room. At this position, the station will have AV patch points via an associated room floorbox for connection to the room' system.

   1) The specified instructor's stations will house the following: remote control touchscreen, keyboard/mouse, and laptop input connections.

   2) The station will be equipped with a task light. Unit to include a single duplex AC power receptacle on the work surface. Laptop access shall be provided.

h. Equipment Rack/Hardware: Provide rack and all equipment rack hardware, including vent panels, slide-out shelves, rack mounts and miscellaneous hardware for a complete and finished system. The equipment rack for this room shall be located as detailed on the AV series drawings. Provide cable management from the rack to associated wall plate.

7. Equipment List: Included in Part 2 of this Section is a consolidated equipment list which includes all equipment for this space. Each of these items shall be priced using both the equipment make and model shown, or components with equivalent functionality and of newer make, which meet or exceed the performance characteristics that are outlined for each component in the list. If an item is listed as "Custom," this means that the Contractor may use any manufacturer's component appropriate for the function and quality required for that item. Submit a "build" quality shop drawing for approval, on any custom items.

END OF SECTION 274100

SECTION 274113 - MULTIMEDIA SYSTEMS FLOORBOX

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Multimedia Systems Floorbox.

B. Related Sections include the following:

1. Division 09 Section *Floor Coverings*.
2. Division 26 *Electrical Sections*
3. Division 27 for *audiovisual systems, telecommunications systems*.

1.2 PERFORMANCE REQUIREMENTS

A. General: Floor boxes provide interface between power, audiovisual, and telecommunications cabling in concrete floors and decks at workstations or at activation locations requiring power, audiovisual, or communication device outlets.

1. ADA Compliance: Flush-mounted floor device outlets shall not create tripping hazard.

B. Floor Mounted Connector Assembly: Watertight, rubber cable pass thru gasketed door and cover assembly, utilizing basket and connector mounting panel inserts. Customize cover/door opening so that cable pass-thru will accommodate the bundle of AV cabling specified, while maintaining the ability to fully close with cables connected.

C. Labeling: Floor boxes shall bear the “cULus mark” issued by UL for units complying with both US and Canadian Standards.

D. Standards: Comply with the following:

1. UL 514A.
2. National Electrical Code.

1.3 SUBMITTALS

A. Comply with requirements of Section 01 33 00 - Submittal Procedures.

B. Submittal data is to be submitted in a three ring binder, a continuous spiral binder, or plastic binding that allows the booklet to lie flat while open. Each booklet shall contain the below in the following order:

1. Cover Sheet.

a. Include name of supplying contractor and project name.

2. Product Data.

a. Include a catalog sheet per product. Each catalog sheet shall describe mechanical, electrical and functional equipment specifications. The catalog sheet must also include an image of the product. Photocopy duplications of the manufacturer's original equipment catalog sheets will be allowed as long as they provide adequate clarity of both the printed word and graphics/pictures. If more than one product is shown on the catalog sheet the intended product must be denoted by either an arrow or highlight.

3. Informational Submittals.

a. Manufacturer's installation instructions.

C. Shop Drawings are to be submitted on project standard full size and bound. Each shop drawing set is to include the below in the following order:

1. Detailed riser drawing indicating conduit runs and associated (box knockout) cables within.
2. Floor plans showing floorbox locations based on column grid lines.

D. Photos

1. Submit a photo of each placed floorbox with associated conduit prior to slab pour.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Multimedia Systems Floorbox:

1. RFB-11, Wiremold

2.2 MATERIALS

A. Door and Cover: Not lighter than 11 gauge steel with integral, self trimming carpet trim ring. Mount trim ring flush with floor covering. Secure with security socket head screws. Coordinate cover finish and material with architect.

1. Finish: Satin black coating.
2. Trim: Door, cover, and integral trim ring shall have radiused corners.

B. Device Plates

1. Provide device plates as detailed on drawings.
2. Provide blank plates as necessary

C. Boxes:

1. 11 gauge steel, 14 5/16 inches by 12 1/8 inches by 6 1/8 inches deep.
2. Mount on manufacturer's backbox.

D. Provide pull strings in each conduit at floor box location. Coordinate conduit to box knockout location with telecommunication cabling and audiovisual systems requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The minimum concrete pour depth shall be 7 inches less decking. For pour depths less than 7 inches provide structural bracing and firestopping as necessary.

B. With Installer present, verify that manufacturer's requirements for floor opening and infrastructure conditions have been satisfactorily met. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Arrange for jobsite approval of the equipment prior to commencing installation.

B. Verify exact locations of floorbox installation.

3.3 INSTALLATION

A. Install equipment in compliance with approved shop drawings and manufacturer's installation instructions.

B. Install in position and relationship to adjoining work indicated, securely anchored to supporting structure, sealed and finished, and in a manner, which produces a level box with square, plumb, and straight edges.

C. Coordinate installation with floor covering to finish each floor box. Install floor covering with oversized cable management pop-up pass-thru in top, matching surrounding floor covering in cover insert.

3.4 ADJUSTING

A. Adjust door/cover for proper operation.

3.5 PROTECTION

A. Protect installed equipment in original undamaged condition until Substantial Completion. Replace damaged components for units that cannot be repaired prior to Substantial Completion.

END OF SECTION 274113

SECTION 283115 - FIRE ALARM SYSTEM

PART 1 – GENERAL

1.1 SUMMARY

A. This Section covers fire alarm systems, including initiating devices, notification appliances, controls, and supervisory devices.

B. Work covered by this section includes the furnishing of labor, equipment, and materials for installation of the fire alarm system as indicated on the drawings and specifications.

C. The Fire Alarm System shall consist of all necessary hardware equipment and software programming to perform the following functions:

1. Fire alarm and detection operations
2. Control and monitoring of elevators, smoke control equipment, door hold-open devices, fire suppression systems, emergency power systems, and other equipment as indicated in the drawings and specifications.
3. Two-way supervised firefighter's phone operations.
4. One-way supervised automatic voice alarm operations.

1.2 ACCEPTABLE MANUFACTURERS

A. Manufacturers: The equipment and service described in this specification are those supplied and supported by SimplexGrinnell and represent the base bid for the equipment.

1. Subject to compliance with requirements, provide alternate products by one of the following:

a) SimplexGrinnell

B. Being listed as an acceptable Manufacturer in no way relieves obligation to provide all equipment and features in accordance with these specifications.

C. The Manufacturer shall be a nationally recognized company specializing in fire alarm and detection systems. This organization shall employ factory trained and NICET certified technicians, and shall maintain a service organization within 100 miles of this project location. The Manufacturer and service organization shall have a minimum of 10 years experience in the fire protective signaling systems industry.

1.3 RELATED DOCUMENTS

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

B. The work covered by this section is to be coordinated with related work as specified elsewhere in the specifications. Requirements of the following sections apply:

1. Division 16: "Basic Electrical Materials and Methods."
2. Division 16: "Wiring Methods."
3. Division 13: "Fire Suppression"
4. Division 15: "Fire Protection"

5. Division 15: "HVAC Systems"
6. Division 13: "Building Automation and Control"

C. The system and all associated operations shall be in accordance with the following:

1. Guidelines of the following Building Code: BOCA SBCCI ICBO UBC IBC
2. NFPA 72, National Fire Alarm Code
3. NFPA 70, National Electrical Code
4. NFPA 101, Life Safety Code
5. NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems
6. Other applicable NFPA standards
7. Local Jurisdictional Adopted Codes and Standards
8. ADA Accessibility Guidelines

1.4 SYSTEM DESCRIPTION

A. General: Provide a complete, non-coded, addressable/conventional, microprocessor-based fire alarm system with initiating devices, notification appliances, and monitoring and control devices as indicated on the drawings and as specified herein.

B. Software: The fire alarm system shall allow for loading and editing instructions and operating sequences as necessary. The system shall be capable of on-site programming to accommodate system expansion and facilitate changes in operation. All software operations shall be stored in a non-volatile programmable memory within the fire alarm control unit. Loss of primary and secondary power shall not erase the instructions stored in memory. System shall be capable of storing dual configuration programs with one active and one in reserve. Panel shall be capable of full system operation during a new configuration download.

C. History Logs: The system shall provide a means to recall alarms and trouble conditions in chronological order for the purpose of recreating an event history. A separate alarm and trouble log shall be provided.

D. Recording of Events: Record all alarm, supervisory, and trouble events by means of system printer. The printout shall include the type of signal (alarm, supervisory, or trouble) the device identification, date and time of the occurrence. The printout differentiates alarm signals from all other printed indications.

E. Wiring/Signal Transmission:

1. Transmission shall be hard-wired, using separate individual circuits for each zone of alarm operation as required or addressable signal transmission, dedicated to fire alarm service only].
2. System connections for initiating (signaling) circuits and notification appliance circuits shall be Class B.
3. Circuit Supervision: Circuit faults shall be indicated by a trouble signal at the FACP. Provide a distinctive indicating audible tone and alphanumeric annunciation.

F. Remote Access:

1. FACP shall have the capability to provide Remote Access through a Dial-Up Service

Modem using the public switched telephone system of a private switched telephone system.

2. A personal computer or technician's laptop, configured with terminal emulation software shall have the ability to access the FACP for diagnostics, maintenance reporting and information gathering.

3. FACP shall have the capability to provide Remote Access through a listed Internet Interface via a standard web browser user interface.

G. Required Functions: The following are required system functions and operating features:

1. Priority of Signals: Alarm events have highest priority. Subsequent alarm events are queued in the order received and do not affect existing alarm conditions. Priority Two, Supervisory and Trouble events have second-, third-, and fourth-level priority respectively. Signals of a higher-level priority take precedence over signals of lower priority even though the lower-priority condition occurred first. Annunciate all events regardless of priority or order received.

2. Noninterfering: An event on one zone does not prevent the receipt of signals from any other zone. All zones are manually resettable from the FACP after the initiating device or devices are restored to normal. The activation of an addressable device does not prevent the receipt of signals from subsequent activations.

3. Transmission to Remote Central Station: Automatically route alarm, supervisory, and trouble signals to a remote central station service transmitter provided under another contract.

4. Annunciation: Operation of alarm and supervisory initiating devices shall be annunciated at the FACP and the remote annunciator, indicating the location and type of device.

5. General Alarm: A system general alarm shall include:

   a) Indication of alarm condition at the FACP and annunciator(s).

   b) Identification of the device or zone that is the source of the alarm at the FACP.

   c) Operation of audible and visible notification devices throughout the building until silenced at FACP.

   d) Closing doors normally held open by magnetic door holders.

   e) Unlocking designated doors.

   f) Shutting down supply and return fans serving zone where alarm is initiated.

   g) Closing smoke dampers on system serving zone where alarm is initiated.

   h) Initiation of smoke control sequence through the building temperature control system.

   i) Notifying the local fire department.

   j) Initiation of elevator recall in accordance with ASME/ANSI A17.1, when specified detectors or sensors are activated.

6. Supervisory Operations: Upon activation of a supervisory device such as fire pump power failure, low air pressure switch, and tamper switch, the system shall operate as

follows:

a) Activate the system supervisory service audible signal and illuminate the LED at the control unit and the graphic annunciator.

b) Pressing the Supervisory Acknowledge Key will silence the supervisory audible signal while maintaining the Supervisory LED "on" indicating off-normal condition.

c) Record the event in the FACP historical log.

d) Transmission of supervisory signal to remote central station.

e) Restoring the condition shall cause the Supervisory LED to clear and restore the system to normal.

7. Alarm Silencing: If the "Alarm Silence" button is pressed, all audible alarm signals shall cease operation.

8. System Reset

a) The "System Reset" button shall be used to return the system to its normal state. Display messages shall provide operator assurance of the sequential steps ("IN PROGRESS", "RESET COMPLETED") as they occur. The system shall verify all circuits or devices are restored prior to resetting the system to avoid the potential for re-alarming the system. The display message shall indicate "ALARM PRESENT, SYSTEM RESET ABORTED."

b) Should an alarm condition continue, the system will remain in an alarmed state.

9. A manual evacuation (drill) switch shall be provided to operate the notification appliances without causing other control circuits to be activated.

10. WALKTEST: The system shall have the capacity of 8 programmable passcode protected one person testing groups, such that only a portion of the system need be disabled during testing. The actuation of the "enable one person test" program at the control unit shall activate the "One Person Testing" mode of the system as follows:

a) The city circuit connection and suppression release circuits shall be bypassed for the testing group.

b) Control relay functions associated to one of the 8 testing groups shall be bypassed.

c) The control unit shall indicate a trouble condition.

d) The alarm activation of any initiation device in the testing group shall cause the audible notification appliances to sound a voice announcement to identify the device or zone.

e) The unit shall automatically reset itself after signaling is complete.

f) Any momentary opening of an initiating or notification appliance circuit wiring shall cause the audible signals to voice announce the trouble condition.

H. Analog Smoke Sensors:

1. Monitoring: FACP shall individually monitor sensors for calibration, sensitivity, and

alarm condition, and shall individually adjust for sensitivity. The control unit shall determine the condition of each sensor by comparing the sensor value to the stored values.

2. Environmental Compensation: The FACP shall maintain a moving average of the sensor's smoke chamber value to automatically compensate for dust, dirt, and other conditions that could affect detection operations.

3. Programmable Sensitivity: Photoelectric Smoke Sensors shall have 7 sensitivity levels ranging from 0.2% to 3.7%, programmed and monitored from the FACP.

4. Sensitivity Testing Reports: The FACP shall provide sensor reports that meet NFPA 72 calibrated test method requirements. The reports shall be viewed on a CRT Display or printed for annual recording and logging of the calibration maintenance schedule.

5. The FACP shall automatically indicate when an individual sensor needs cleaning. The system shall provide a means to indicate that a sensor requires cleaning. When a sensor's average value reaches a predetermined value, (3) progressive levels of reporting are provided. The first level shall indicate that a sensor is close to a trouble reporting condition and will be indicated on the FACP as "ALMOST DIRTY." This condition provides a means to alert maintenance staff of a dirty sensor without creating a trouble in the system. If this indicator is ignored, a second level "DIRTY SENSOR" condition shall be indicated at the FACP and subsequently a system trouble is reported to the Central Monitoring Station. The sensor base LED shall glow steady giving a visible indication at the sensor location. The "DIRTY SENSOR" condition shall not affect the sensitivity level required to alarm the sensor. If a "DIRTY SENSOR" is left unattended, and its average value increases to a third predetermined value, an "EXCESSIVELY DIRTY SENSOR" trouble condition shall be indicated at the control unit.

6. The FACP shall continuously perform an automatic self-test on each sensor which will check sensor electronics and ensure the accuracy of the values being transmitted. Any sensor that fails this test shall indicate a "SELF TEST ABNORMAL" trouble condition.

7. Multi-Sensors shall combine photoelectric smoke sensing and heat sensing technologies. An alarm shall be determined by either smoke detection, with selectable sensitivity from 0.2 to 3.7 %/ft obscuration; or heat detection, selectable as fixed temperature or fixed with selectable rate-of-rise; or based on an analysis of the combination of smoke and heat activity.

8. Programmable bases. It shall be possible to program relay and sounder bases to operate independently of their associated sensor.

9. Magnet test activation of smoke sensors shall be distinguished by its label and history log entry as being activated by a magnet.

I. Smoke Detectors: A maintenance and testing service providing the following shall be included with the base bid:

1. Biannual sensitivity reading and logging for each smoke sensor.

2. Scheduled biannual threshold adjustments to maintain proper sensitivity for each smoke sensor.

3. Threshold adjustment to any smoke sensor that has alarmed the system without the

presence of particles of combustion.

4. Scheduled biannual cleaning or replacement of each smoke detector or sensor within the system.
5. Semi-annual functional testing of each smoke detector or sensor using the manufacturer's calibrated test tool.
6. Written documentation of all testing, cleaning, replacing, threshold adjustment, and sensitivity reading for each smoke detector or sensor device within the system.
7. The initial service included in the bid price shall provide the above listed procedures for a period of five years after owner acceptance of the system.

J. Audible Alarm Notification: By voice evacuation and tone signals on loudspeakers in areas as indicated on drawings.

1. Automatic Voice Evacuation Sequence:
   a) The audio alarm signal shall consist of an alarm tone for a maximum of five seconds followed by an automatic digital voice message. At the end of the voice message, the alarm tone shall resume. This sequence shall sound continuously until the "Alarm Silence" switch is activated.
   b) All audio operations shall be activated by the system software so that any required future changes can be facilitated by authorized personnel without any component rewiring or hardware additions.

K. Speaker: Speaker notification appliances shall be listed to UL 1480.

1. The speaker shall operate on a standard 25VRMS or 70.7VRMS NAC using twisted/shielded wire.
2. The following taps are available: 0.25W, 0.50W, 1.0W and 2.0W. At the 1.0W tap, the speaker has minimum UL rated sound pressure level of 84dBA at 10 feet.
3. The speaker shall have a frequency response of 400 to 4000 Hz for Fire Alarm and 125 to 12kHz for General Signaling.

L. Manual Voice Paging

1. The system shall be configured to allow voice paging. Upon activation of any speaker manual control switch, the alarm tone shall be sounded over all speakers in that group.
2. The control panel operator shall be able to make announcements via the push-to-talk paging microphone over the pre-selected speakers.
3. Facility for total building paging shall be accomplished by the means of an "All Call" switch.

M. Firefighter's phone: Provide a supervised, two-way communication system between the Command Center/main fire alarm control panel and emergency phones.

1. The firefighter's phone system shall be capable of handling single or simultaneous conversations with all phones connected into the system. As many as seven (7) phones shall be able to be connected into the active conversation.
2. The phone system circuits shall be designed to prevent static, hum or other interference for clear, intelligible two-way conversation between all phones of the system.

3. The phone system circuits shall be supervised, such that the FACP shall be able to differentiate between whether a handset has been plugged into the emergency phone jack or whether the circuit has a shorted wire.
4. A beeping busy signal shall indicate to the person attempting to use a remote phone that the signal is being received at the control unit and that the lines are intact.
5. The act of plugging a handset into an emergency phone jack or removal of any phone from its normal hook position shall cause an audible and visual indication at the control unit. Picking up the master phone and acknowledgment of the phone circuit shall silence the tone and allow for direct two-way communications.
6. The act of unplugging handsets in use and replacement of remote phones will return the phone circuits to their normal supervisory functions.
7. Provide emergency phone jacks for installation in each elevator car by the elevator contractor. Required wiring from elevator controls to each elevator car shall be furnished and installed by the elevator contractor.
8. Provide emergency phone jacks as shown on the plans. Each jack shall be mounted on a stainless steel single gang plate with the words "Fire Emergency Phone" screened on each.
9. Provide a minimum of five (5) pluggable emergency phones within a storage cabinet.

N. Fire Suppression Monitoring:

1. Water flow: Activation of a water flow switch shall initiate general alarm operations.
2. Sprinkler valve tamper switch: The activation of any valve tamper switch shall activate system supervisory operations.
3. WSO: Water flow switch and sprinkler valve tamper switch shall be capable of existing on the same initiating zone. Activation of either device shall distinctly report which device is in alarm on the initiating zone.

O. Power Requirements

1. The control unit shall receive AC power via a dedicated fused disconnect circuit.
2. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal AC power in a normal supervisory mode for a period of 4 hours with 15 minutes of alarm operation at the end of this period. The system shall automatically transfer to battery standby upon power failure. All battery charging and recharging operations shall be automatic.
3. All circuits requiring system-operating power shall be 24 VDC and shall be individually fused at the control unit.
4. The incoming power to the system shall be supervised so that any power failure will be indicated at the control unit. A green "power on" LED shall be displayed continuously while incoming power is present.
5. The system batteries shall be supervised so that a low battery or depleted battery condition or disconnection of the battery shall be indicated at the control unit and displayed for the specific fault type.
6. The system shall support NAC Lockout feature to prevent subsequent activation of Notification Appliance Circuits after a Depleted Battery condition occurs in order to make use of battery reserve for front panel annunciation and control

7. The system shall support 100% of addressable devices in alarm or operated at the same time, under both primary(AC) and secondary (battery) power conditions.]
8. Loss of primary power shall sound a trouble signal at the FACP. FACP shall indicate when the system is operating on an alternate power supply.

1.5 SUBMITTALS

A. General: Submit the following according to Conditions of Contract and Division 1 Specification Sections.

1. Product data sheets for system components highlighted to indicate the specific products, features, or functions required to meet this specification. Alternate or as-equal products submitted under this contract must provide a detailed line-by-line comparison of how the submitted product meets, exceeds, or does not comply with this specification.
2. Wiring diagrams from manufacturer.
3. Shop drawings showing system details including location of FACP, all devices, circuiting and details of graphic annunciator.
4. System Power and battery charts with performance graphs and voltage drop calculations to assure that the system will operate per the prescribed backup time periods and under all voltage conditions per UL and NFPA standards.
5. System operation description including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and outputs. A list of all input and output points in the system shall be provided with a label indicating location or use of IDC, NAC, relay, sensor, and auxiliary control circuits.
6. Operating instructions for FACP.
7. Operation and maintenance data for inclusion in Operating and Maintenance Manual. Include data for each type product, including all features and operating sequences, both automatic and manual. Provide the names, addresses, and telephone numbers of service organizations.
8. Product certification signed by the manufacturer of the fire alarm system components certifying that their products comply with indicated requirements.
9. Record of field tests of system.

B. Submission to Authority Having Jurisdiction: In addition to routine submission of the above material, make an identical submission to the authority having jurisdiction. Include copies of shop drawings as required to depict component locations to facilitate review. Upon receipt of comments from the Authority, make resubmissions if required to make clarifications or revisions to obtain approval.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A factory authorized installer is to perform the work of this section.

B. Each and all items of the Fire Alarm System shall be listed as a product of a single fire alarm system manufacturer under the appropriate category by Underwriters Laboratories, Inc. (UL), and shall bear the "UL" label.

1.7 MAINTENANCE SERVICE

A. Maintenance Service Contract: Provide maintenance of fire alarm systems and equipment for a period of 12 months, using factory-authorized service representatives.

B. Basic Services: Systematic, routine maintenance visits on a quarterly basis at times scheduled with the Owner. In addition, respond to service calls within 24 hours of notification of system trouble. Adjust and replace defective parts and components with original manufacturer's replacement parts, components, and supplies.

C. Additional Services: Perform services within the above 12-month period not classified as routine maintenance or as warranty work when authorized in writing. Compensation for additional services must be agreed upon in writing prior to performing services.

D. Renewal of Maintenance Service Contract: No later than 60 days prior to the expiration of the maintenance services contract, deliver to the Owner a proposal to provide contract maintenance and repair services for an additional one-year term. Owner will be under no obligation to accept maintenance service contract renewal proposal.]

1.8 EXTRA MATERIALS

A. General: Furnish extra materials, packaged with protective covering for storage, and identified with labels clearly describing contents as follows:

1. Break Rods for Manual Stations: Furnish quantity equal to 15 percent of the number of manual stations installed; minimum of 6 rods.
2. Strobe Units: Furnish quantity equal to 10 percent of the number of units installed, but not less than one.
3. Smoke Detectors or Sensors, Fire Detectors, and Flame Detectors: Furnish quantity equal to 10 percent of the number of units of each type installed but not less than one of each type.
4. Detector or Sensor Bases: Furnish quantity equal to 2 percent of the number of units of each type installed but not less than one of each type.
5. Printer Ribbons: Furnish 6 spare printer ribbons.

PART 2 – PRODUCTS

2.1 FIRE ALARM CONTROL PANEL (FACP)

A. General: Comply with UL 864, "Control Units for Fire-Protective Signaling Systems."

B. The following FACP hardware shall be provided:

1. Power Limited base panel with beige cabinet and door, 120 VAC input power.
2. 2,000 point capacity where (1) point equals (1) monitor (input) or (1) control (output).
3. 2,000 points of Network Annunciation at FACP Display when applied as a Network Node
4. 2000 points of annunciation where one (1) point of annunciation equals:

a) 1 LED driver output on a graphic driver or 1 switch input on a graphic switch input module.

b) 1 LED on panel or 1 switch on panel.

5. From all battery charging circuits in the system provide battery voltage and ammeter readouts on the FCP LCD Display.
6. Municipal City Circuit Connection with Disconnect switch, 24VDC Remote Station (reverse polarity), local energy, shunt master box, or a form "C" contact output .
7. One Auxiliary electronically resetable fused 2A @24VDC Output, with programmable disconnect operation for 4-wire detector reset.
8. One Auxiliary Relay, SPDT 2A @32VDC, programmable as a trouble relay, either as normally energized or de-energized, or as an auxiliary control.
9. Where required provide Intelligent Remote Battery Charger for charging up to 110Ah batteries.
10. Power Supplies with integral intelligent Notification Appliance Circuit Class B for system expansion.
11. Four (4) form "C" Auxiliary Relay Circuits (Form C contacts rated 2A @ 24VDC, resistive), operation is programmable for trouble, alarm, supervisory of other fire response functions. Relays shall be capable of switching up to ½ A @ 120VAC, inductive.
12. The FACP shall support (6) RS-232-C ports and one service port.
13. Remote Unit Interface: supervised serial communication channel for control and monitoring of remotely located annunciators and I/O panels.
14. Programmable DACT for either Common Event Reporting or per Point Reporting.
15. Service Port Modem for dial in passcode access to all fire control panel information.

C. Cabinet: Lockable steel enclosure. Arrange unit so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure. If more than a single unit is required to form a complete control unit, provide exactly matching modular unit enclosures.

D. Alphanumeric Display and System Controls: Panel shall include an 80 character LCD display to indicate alarm, supervisory, and component status messages and shall include a keypad for use in entering and executing control commands.

E. Voice Alarm: Provide an emergency communication system, integral with the FACP, including voice alarm system components, microphones, amplifiers, and tone generators. Features include:

1. Amplifiers comply with UL 1711, "Amplifiers for Fire Protective Signaling Systems." Amplifiers shall provide an onboard local mode temporal coded horn tone as a default backup tone. Test switches on the amplifier shall be provided to test and observe amplifier backup switchover. Each amplifier shall communicate to the host panel amplifier and NAC circuit voltage and current levels for display on the user interface.
2. Dual alarm channels permit simultaneous transmission of different announcements to different zones or floors automatically or by use of the central control microphone. All announcements are made over dedicated, supervised communication lines. All risers shall support Class A wiring for each audio channel.
3. Eight channel digitally multiplexed audio for systems that require more than two channels of simultaneous audio. Up to 8 channels of audio shall be multiplexed on

either a style 4 or style 7 twisted pair.

4. Emergency voice communication audio controller module shall provide up to 32 minutes of message memory for digitally stored messages. Provide supervised connections for master microphone and up to 5 remote microphones.

5. Status annunciator indicating the status of the various voice alarm speaker zones and the status of fire fighter telephone two-way communication zones.

F. Fire fighters' telephone communication system: Arrange system to use dedicated, two-way, supervised voice communication links between the FACP and remote fire fighters' telephone stations throughout the building.]

G. Distributed Module Operation: FACP shall be capable of allowing remote location of the following modules; interface of such modules shall be through a Style 7 (Class A) supervised serial communications channel (SLC):

1. Amplifiers, voice and telephone control circuits

2. Addressable Signaling Line Circuits

3. Initiating Device Circuits

4. Notification Appliance Circuits

5. Auxiliary Control Circuits

6. Graphic Annunciator LED/Switch Control Modules

2.2 AUTOCALL SYSTEM INTERFACE

A. When a fire alarm system using existing Autocall XA loop devices requires expansion FACP shall be capable of interfacing to the XA loop via an interface module. This module shall allow the FACP to be selected to function as either the XA loop master controller (head end) or as a Data Gathering Panel as an intelligent device on the XA loop reporting to a remote master controller. Multiple XA Loop Interface Modules can be installed in the FACP allowing a variety of system expansion situations to be satisfied.

2.3 REMOTE CRTS, PC ANNUNCIATOR AND PRINTERs

A. Fire Alarm Control Unit shall be capable of operating remote CRT's and/or printers; output shall be ASCII from an RS-232-C connection with an adjustable baud rate.

B. Fire Alarm Control Unit shall be capable of operating a PC Annunciator which provides status annunciation and limited system control using a convenient and familiar Microsoft Windows® 2000 operating system based interface. PC Annunciator shall provide the following functions:

1. Login/logout password protection with time duration selectable automatic logout

2. Displays Alarm, Supervisory, Priority 2, and Trouble conditions with numerical tallies for each

3. Displays first and last alarms

4. Different event types have separate visible indicators with a common audible indicator

5. Event logs can be searched and printed

6. View and/or print TrueAlarm status reports and service reports (printing requires an available local or network printer)

7. Alarm Silence; System Reset; and Priority 2 Reset
8. Global and individual point acknowledge
9. Set system time and date; and clear event log
10. Individual point access for control or parameter revisions

C. Each RS-232-C port shall be capable of supporting and supervising a remote Printer; the FACP shall support as many as two (2) remote displays. The Fire Alarm Control Panel shall support five (5) RS-232-C ports.

2.4 REMOTE LCD ANNUNCIATOR

A. Provide Remote LCD Annunciator with the same "look and feel" as the FACP operator interface. The Remote LCD Annunciator shall use the same Primary Acknowledge, Silence, and Reset Keys, Status LEDs and LCD Display as the FACP.

B. Annunciator shall have super-twist LCD display with two lines of 40 characters each. Annunciator shall be provided with four (4) programmable control switches and associated LEDs.

C. Under normal conditions the LCD shall display a "SYSTEM IS NORMAL" message and the current time and date.

D. Should an abnormal condition be detected the appropriate LED (Alarm, Supervisory or Trouble) shall flash. The unit audible signal shall pulse for alarm conditions and sound steady for trouble and supervisory conditions.

E. The LCD shall display the following information relative to the abnormal condition of a point in the system:

1. 40 character custom location label.
2. Type of device (e.g., smoke, pull station, waterflow).
3. Point status (e.g., alarm, trouble).

F. Operator keys shall be key switch enabled to prevent unauthorized use. The key shall only be removable in the disabled position. Acknowledge, Silence and Reset operation shall be the same as the FACP.

2.5 EMERGENCY POWER SUPPLY

A. General: Components include battery, charger, and an automatic transfer switch.

B. Battery: Sealed lead-acid. Provide sufficient capacity to operate the complete alarm system in normal or supervisory (non-alarm) mode for a period of 4 hours. Following this period of operation on battery power, the battery shall have sufficient capacity to operate all components of the system, including all alarm indicating devices in alarm or supervisory mode for a period of 15 minutes.

2.6 ADDRESSABLE MANUAL PULL STATIONS

A. Description: Addressable single- or double-action type, red LEXAN, with molded, raised-letter operating instructions of contrasting color. Station will mechanically latch upon operation and remain so until manually reset by opening with a key common with the control units.

B. Protective Shield: Where required provide a tamperproof, clear LEXAN shield and red frame that easily fits over manual pull stations. When shield is lifted to gain access to the

station, a battery powered piercing warning horn shall be activated. The horn shall be silenced by lowering and realigning the shield. The horn shall provide 85dB at 10 feet and shall be powered by a 9 VDC battery.

2.7 SMOKE SENSORS

A. General: Comply with UL 268, "Smoke Detectors for Fire Protective Signaling Systems." Include the following features:

1. Factory Nameplate: Serial number and type identification.
2. Operating Voltage: 24 VDC, nominal.
3. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore normal operation.
4. Plug-In Arrangement: Sensor and associated electronic components are mounted in a module that connects to a fixed base with a twist-locking plug connection. Base shall provide break-off plastic tab that can be removed to engage the head/base locking mechanism. No special tools shall be required to remove head once it has been locked. Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the control unit.
5. Each sensor base shall contain an LED that will flash each time it is scanned by the Control Unit (once every 4 seconds). In alarm condition, the sensor base LED shall be on steady.
6. Each sensor base shall contain a magnetically actuated test switch to provide for easy alarm testing at the sensor location.
7. Each sensor shall be scanned by the Control Unit for its type identification to prevent inadvertent substitution of another sensor type. Upon detection of a "wrong device", the control unit shall operate with the installed device at the default alarm settings for that sensor; 2.5% obscuration for photoelectric sensor, 135-deg F and 15-deg F rate-of-rise for the heat sensor, but shall indicate a "Wrong Device" trouble condition.
8. The sensor's electronics shall be immune from false alarms caused by EMI and RFI.
9. Sensors include a communication transmitter and receiver in the mounting base having a unique identification and capability for status reporting to the FACP. Sensor address shall be located in base to eliminate false addressing when replacing sensors.
10. Removal of the sensor head for cleaning shall not require the setting of addresses.

B. Type: Smoke sensors shall be of the photoelectric or combination photoelectric / heat type. Where acceptable per manufacturer specifications, ionization type sensors may be used.

C. Bases: Relay output, sounder and isolator bases shall be supported alternatives to the standard base.

D. Duct Smoke Sensor: Photoelectric type, with sampling tube of design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied. Sensor includes relay as required for fan shutdown.

1. Environmental compensation, programmable sensitivity settings, status testing, and monitoring of sensor dirt accumulation for the duct sensor shall be provided by the FACP.
2. The Duct Housing shall provide a supervised relay driver circuit for driving up to 15

relays with a single "Form C" contact rated at 7A@ 28VDC or 10A@ 120VAC. This auxiliary relay output shall be fully programmable. Relay shall be mounted within 3 feet of HVAC control circuit.

3. Duct Housing shall provide a relay control trouble indicator Yellow LED.
4. Compact Duct Housing shall have a transparent cover to monitor for the presence of smoke. Cover shall secure to housing by means of four (4) captive fastening screws.
5. Duct Housing shall provide two (2) Test Ports for measuring airflow and for testing. These ports will allow aerosol injection in order to test the activation of the duct smoke sensor.
6. Duct Housing shall provide a magnetic test area and Red sensor status LED.
7. For maintenance purposes, it shall be possible to clean the duct housing sampling tubes by accessing them through the duct housing front cover.
8. Each duct sensor shall have a Remote Test Station with an alarm LED and test switch.
9. Where indicated a NEMA 4X weatherproof duct housing enclosure shall provide for the circulation of conditioned air around the internally mounted addressable duct sensor housing to maintain the sensor housing at its rated temperature range. The housing shall be UL Listed to Standard 268A.]

2.8 HEAT SENSORS

A. Thermal Sensor: Combination fixed-temperature and rate-of-rise unit with plug-in base and alarm indication lamp; 135-deg F fixed-temperature setting except as indicated.

B. Thermal sensor shall be of the epoxy encapsulated electronic design. It shall be thermistor-based, rate-compensated, self-restoring and shall not be affected by thermal lag.

C. Sensor fixed temperature sensing shall be independent of rate-of-rise sensing and] programmable to operate at 135-deg F or 155-deg F. Sensor rate-of-rise temperature detection shall be selectable at the FACP for either 15-deg F or 20-deg F per minute.

D. Sensor shall have the capability to be programmed as a utility monitoring device to monitor for temperature extremes in the range from 32-deg F to 155-deg F.

2.9 ADDRESSABLE CIRCUIT INTERFACE MODULES

A. Addressable Circuit Interface Modules: Arrange to monitor one or more system components that are not otherwise equipped for addressable communication. Modules shall be used for monitoring of waterflow, valve tamper, non-addressable devices, and for control of evacuation indicating appliances and AHU systems.

B. Addressable Circuit Interface Modules will be capable of mounting in a standard electric outlet box. Modules will include cover plates to allow surface or flush mounting. Modules will receive their operating power from the signaling line or a separate two wire pair running from an appropriate power supply as required.

C. There shall be the following types of modules:

1. Type 1: Monitor Circuit Interface Module:

a) For conventional 2-wire smoke detector and/or contact device monitoring with Class B or Class A wiring supervision. The supervision

of the zone wiring will be Class B. This module will communicate status (normal, alarm, trouble) to the FACP.

b) For conventional 4-wire smoke detector with Class B wiring supervision. The module will provide detector reset capability and over-current power protection for the 4-wire detector. This module will communicate status (normal, alarm, trouble) to the FACP.

2. Type 2: Line Powered Monitor Circuit Interface Module

a) This type of module is an individually addressable module that has both its power and its communications supplied by the two wire multiplexing signaling line circuit. It provides location specific addressability to an initiating device by monitoring normally open dry contacts. This module shall have the capability of communicating four zone status conditions (normal, alarm, current limited, trouble) to the FACP.

b) This module shall provide location specific addressability for up to five initiating devices by monitoring normally closed or normally open dry contact security devices. The module shall communicate four zone status conditions (open, normal, abnormal, and short). The two-wire signaling line circuit shall supply power and communications to the module.

3. Type 3: Single Address Multi-Point Interface Modules

a) This multipoint module shall provide location specific addressability for four initiating circuits and control two output relays from a single address. Inputs shall provide supervised monitoring of normally open, dry contacts and be capable of communicating four zone status conditions (normal, open, current limited, and short). The input circuits and output relay operation shall be controlled independently and disabled separately.

b) This dual point module shall provide a supervised multi-state input and a relay output, using a single address. The input shall provide supervised monitoring of two normally open, dry contacts with a single point and be capable of communicating four zone status conditions (normal, open, current limited, and short). The two-wire signaling line circuit shall supply power and communications to the module.

c) This dual point module shall monitor an unsupervised normally open, dry contact with one point and control an output relay with the other point, using a single address. The two-wire signaling line circuit shall supply power and communications to the module.

4. Type 4: Line Powered Control Circuit Interface Module

a) This module shall provide control and status tracking of a Form "C" contact. The two-wire signaling line circuit shall supply power and communications to the module.

5. Type 5: 4-20 mA Analog Monitor Circuit Interface Module

a) This module shall communicate the status of a compatible 4-20 mA sensor to the FACP. The FACP shall annunciate up to three threshold levels, each with custom action message; display and archive actual

sensor analog levels; and permit sensor calibration date recording.

D. All Circuit Interface Modules shall be supervised and uniquely identified by the control unit. Module identification shall be transmitted to the control unit for processing according to the program instructions. Modules shall have an on-board LED to provide an indication that the module is powered and communicating with the FACP. The LEDs shall provide a troubleshooting aid since the LED blinks on poll whenever the peripheral is powered and communicating.

2.10 MAGNETIC DOOR HOLDERS

A. Description: Units shall be listed to UL 228. Units are equipped for wall or floor mounting as indicated and are complete with matching door plate. Unit shall operate from a 120VAC, a 24VAC or a 24VDC source, and develops a minimum of 25 lbs. holding force.

B. Material and Finish: Match door hardware.

2.11 ADDRESSABLE ALARM NOTIFICATION APPLIANCES

A. Addressable Notification Appliances: The Contractor shall furnish and install Addressable Notification Appliances and accessories to operate on compatible signaling line circuits (SLC).

1. Addressable Notification appliance operation shall provide power, supervision and separate control of horns and strobes over a single pair of wires. The controlling channel (SLC) digitally communicates with each appliance and receives a response to verify the appliance's presence on the channel. The channel provides a digital command to control appliance operation. SLC channel wiring shall be unshielded twisted pair (UTP), with a capacitance rating of less than 60pf/ft and a minimum 3 twists (turns) per foot.

2. Class B (Style 4) notification appliances shall be wired without requiring traditional in/out wiring methods; addressable "T" Tapping shall be permitted. Up to 63 appliances can be supported on a single channel.

3. Each Addressable notification appliance shall contain an electronic module and a selectable address setting to allow it to occupy a unique location on the channel. This on-board module shall also allow the channel to perform appliance diagnostics that assist with installation and subsequent test operations. A visible LED on each appliance shall provide verification of communications and shall flash with the appliances address setting when locally requested using a magnetic test tool.

B. Addressable Controller: Addressable Controller shall supervise Channel (SLC) wiring, communicate with and control addressable notification appliances. It shall be possible to program the High/Lo setting of the audible (horn) appliances by channel from the addressable controller.

C. Horn: Addressable horn shall be listed to UL 464. Horn appliances shall have a High/Lo Setting, programmable by channel from the addressable controller or by appliance from the host FACP. The horn shall have a minimum sound pressure level of 83 or 89 dBA @ 24VDC. The horn shall mount directly to a standard single gang, double gang or 4" square electrical box, without the use of special adapter or trim rings. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot.

D. Visible/Only: Addressable strobe shall be listed to UL 1971. The V/O shall consist of a xenon flash tube and associated lens/reflector system. The V/O enclosure shall mount

directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot. V/O appliances shall be provided with different minimum flash intensities of 15cd, 75cd and 110cd. Provide a label inside the strobe lens to indicate the listed candela rating of the specific Visible/Only appliance.

E. Audible/Visible: Addressable combination Audible/Visible (A/V) Notification Appliances shall be listed to UL 1971 and UL 464. The strobe light shall consist of a xenon flash tube and associated lens/reflector system. Provide a label inside the strobe lens to indicate the listed candela rating of the specific strobe. The horn shall have a minimum sound pressure level of 83 or 89 dBA @ 24VDC. The audible/visible enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot. The appliance shall be capable of two-wire synchronization with one of the following options:

1. Synchronized Strobe with Horn on steady
2. Synchronized Strobe with Temporal Code Pattern on Horn
3. Synchronized Strobe with March Time cadence on Horn
4. Synchronized Strobe firing to NAC sync signal with Horn silenced

F. Speaker/Visible: Combination Speaker/Visible (S/V) units combine the speaker and visible functions into a common housing. The S/V shall be listed to UL 1971 and UL 1480. Addressable functionality controls visible operation, while the speaker operates on a 25VRMS or 70.7VRMS NAC.

1. Twisted/shielded wire is required for speaker connections on a standard 25VRMS or 70.7VRMS NAC using and UTP conductors, having a minimum of 3 twists per foot is required for addressable strobe connections.
2. The following taps are available: 0.25W, 0.50W, 1.0W and 2.0W. At the 1.0W tap, the speaker has minimum UL rated sound pressure level of 84dBA at 10 feet.
3. The S/V shall have a frequency response of 400 to 4000 Hz for Fire Alarm and 125 to 12kHz for General Signaling.
4. The S/V installs directly to a 4" square, 1 1/2 in. deep electrical box with 1 1/2" extension

G. Isolator Module: Isolator module provides short circuit isolation for addressable notification appliance SLC wiring. Isolator shall be listed to UL 864. The Isolator shall mount directly to a minimum 2 1/8" deep, standard 4" square electrical box, without the use of special adapter or trim rings. Power and communications shall be supplied by the Addressable Controller channel SLC; dual port design shall accept communications and power from either port and shall automatically isolate one port from the other when a short circuit occurs. The following functionality shall be included in the Isolator module:

1. Report faults to the host FACP.
2. On-board Yellow LED provides module status.
3. After the wiring fault is repaired, the Isolator modules shall test the lines and automatically restore the connection.

H. Accessories: The contractor shall furnish the necessary accessories.

2.12 TRUEALERT ADDRESSABLE APPLIANCES NAC POWER EXTENDER

A. The TrueAlert Addressable Controller shall be a stand-alone panel capable of powering a minimum of 3 TrueAlert Signaling line circuits. Each channel shall be rated for 2.5 amps and support up to 63 TrueAlert addressable notification appliances. Power and communication for the notification appliances shall be provided on the same pair of wires.

B. Addressable SLC notification appliance circuits shall be Class B Style 4.

C. The internal power supply & battery charger shall be capable of charging up 12.7 Ah batteries internally mounted or 18Ah batteries mounted in an external cabinet.

D. The NAC extender panel may be mounted close to the host control panel or can be remotely located.

PART 3 – EXECUTION

3.1 INSTALLATION, GENERAL

A. Install system components and all associated devices in accordance with applicable NFPA Standards and manufacturer's recommendations.

B. Installation personnel shall be supervised by persons who are qualified and experienced in the installation, inspection, and testing of fire alarm systems. Examples of qualified personnel shall include, but not be limited to, the following:

1. Factory trained and certified personnel.
2. National Institute of Certification in Engineering Technologies (NICET) fire alarm level II certified personnel.
3. Personnel licensed or certified by state or local authority.

3.2 EQUIPMENT INSTALLATION

A. Furnish and install a complete Fire Alarm System as described herein and as shown on the plans. Include sufficient control unit(s), annunciator(s), manual stations, automatic fire detectors, smoke detectors, audible and visible notification appliances, wiring, terminations, electrical boxes, and all other necessary material for a complete operating system.

B. Water-Flow and Valve Supervisory Switches: Connect for each sprinkler valve required to be supervised.

C. Device Location-Indicating Lights: Locate in the public space immediately adjacent to the device they monitor.

3.3 WIRING INSTALLATION

A. System Wiring: Wire and cable shall be a type listed for its intended use by an approval agency acceptable to the Authority Having Jurisdiction (AH and shall be installed in accordance with the appropriate articles from the current approved edition of NFPA 70: National Electric Code (NEC). All wiring shall be plenum-rated power-limited (FPLP) cable installed in EMT conduit.

B. Contractor shall obtain from the Fire Alarm System Manufacturer written instruction regarding the appropriate wire/cable to be used for this installation. No deviation from the written instruction shall be made by the Contractor without the prior written approval of the Fire Alarm System Manufacturer.

C. Color Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color code for alarm initiating device circuits wiring and a different color code for supervisory circuits. Color-code notification appliance circuits differently from alarm-initiating circuits. Paint fire alarm system junction boxes and covers red.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.

B. Service personnel shall be qualified and experienced in the inspection, testing, and maintenance of fire alarm systems. Examples of qualified personnel shall be permitted to include, but shall not be limited to, individuals with the following qualifications:

1. Factory trained and certified.
2. National Institute for Certification in Engineering Technologies (NICET) fire alarm certified.
3. International Municipal Signal Association (IMSA) fire alarm certified.
4. Certified by a state or local authority.
5. Trained and qualified personnel employed by an organization listed by a national testing laboratory for the servicing of fire alarm systems.

C. Pretesting: Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved.

D. Final Test Notice: Provide a 10-day minimum notice in writing when the system is ready for final acceptance testing.

E. Minimum System Tests: Test the system according to the procedures outlined in NFPA 72.

F. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

G. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log.

H. Final Test, Certificate of Completion, and Certificate of Occupancy:

1. Test the system as required by the Authority Having Jurisdiction in order to obtain a certificate of occupancy.

3.5 CLEANING AND ADJUSTING

A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Clean unit internally using methods and materials recommended by manufacturer.

B. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels and adjusting controls and sensitivities to suit actual occupied conditions. Provide up to three visits to the site for this purpose.

3.6 TRAINING

A. Provide the services of a factory-authorized service representative to demonstrate the system and train Owner's maintenance personnel as specified below.

1. Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintaining of the system. Provide a minimum of 8 hours' training.

2. Schedule training with the Owner at least seven days in advance.

END OF SECTION 283115