MADISON AND WASHINGTON ELEMENTARY SCHOOLS ADDITION & RENOVATION HURON SCHOOL DISTRICT 2-2 HURON, SOUTH DAKOTA VOLUME 2 OF 2

PROJECT MANUAL

PROJECT NO.: 1277

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MADISON AND WASHINGTON ELEMENTARY SCHOOLS ADDITION & RENOVATION
HURON SCHOOL DISTRICT 2-2
HURON, SOUTH DAKOTA

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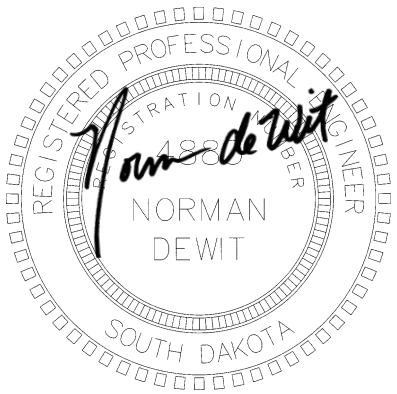

ACEI PROJECT NO.: 113059

DATE: February 19, 2014

Project Manual sections prepared by or under the supervision of Norman deWit, Reg No. 4883, include all sections of Divisions 21,22,23.

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SECTION 210500 - FIRE SUPPRESSION

1.01 SCOPE:

The GENERAL, SUPPLEMENTAL and other CONDITIONS of the Contract and the GENERAL REQUIREMENTS (Division 1) are hereby made part of this Section.

Section 210100, General Provisions, in its entirety, including references to the General Construction Specifications, are hereby adopted and made a part of these Specifications.

The Work involved in this specification and the accompanying Drawings consists of performing all labor and furnishing of all materials, fixtures and equipment necessary to install a complete fire protection system as described herein and/or shown on the Drawings. This includes all piping, wiring and materials obviously necessary for complete systems though not specifically mentioned or shown.

The fire protection system shall be a wet system. The system in office areas shall be designed for light hazardous classification. The storage and mechanical areas shall be designed for ordinary hazard, group 1 classification. Provide coverage for all concealed combustible spaces including, but not limited to the attics. The system shall be complete with sprinkler heads, piping, valves, alarm bell, fire department connection and controls necessary for a complete system.

Water supply flow test information shall be obtained from the City of Sioux Falls, SD.

1.02 CONTRACTOR QUALIFICATIONS:

The Contractor for the Fire Protection installation shall be a qualified Fire Protection Contractor regularly engaged in the installation of Automatic Fire Sprinkler Systems and other Fire Protection Equipment.

1.03 AUTHORITIES AND AGENCIES:

All work will be installed for the approval and acceptance of the Fire Chief of the City of Sioux Falls, SD.

All material, equipment, valves and devices installed or furnished under this Section shall be listed or approved for use in the fire protection installation by the authorities, agencies, codes and standards named in this Section of the Specifications:

Underwriters Laboratories - Approved Fire Protection.
NFPA Pamphlet No. 13.
Factory Mutual.

1.04 DESIGN AND INSTALLATION STANDARDS:

The Fire Protection System shall be designed and installed to comply with the following standards and/or codes of the latest issue:

NFPA Pamphlet No. 13 - Sprinkler Systems.
Building Code of the City of Sioux Falls, SD.

1.05 WORKING DRAWINGS:

Before commencing with the sprinkler installation, the Fire Protection Contractor shall submit Working Drawings to the authorities having jurisdiction and agencies specified for review and approval and/or acceptance. Following approval by authorities and agencies having jurisdiction, the Contractor shall submit the Drawings to the Architect/Engineer in accordance with the General Conditions and Section 210100, GENERAL PROVISIONS - SHOP DRAWINGS.

1.06 INSPECTION AND TESTS:

All inspections, examinations and tests required by the authorities and agencies specified shall be arranged and paid for by the Fire Protection Contractor as necessary, to obtain complete and final acceptance of the Fire Protection System.

1.07 CONTRACTOR'S CERTIFICATE:

After completion of the fire protection installation and at the start of the guarantee year, the Fire Protection Contractor shall execute and file five (5) copies of the "Contractor's Material and Test Certificate, Sprinkler systems - Water Spray Systems" with the Architect. At the time of final inspection the following maintenance shall be performed:

Operation of all control valves.

Lubrication of operation stems of all interior control valves.

Operation of alarm bell.

Cleaning of sprinkler valves.

Lubrication of fire protection inlet water connections.

1.08 PIPE AND PIPE FITTINGS:

Refer to the requirements of Section 210100 - General Provisions, subsection Pipe and Pipe Fittings.

All piping installed in exposed locations shall be designated as such in the Shop Drawing submittals. All piping installed exposed in finished spaces such as skylights shall be copper pipe and fittings.

1.09 SPRINKLER HEADS:

Sprinkler heads shall be standard semi-recessed chrome-plated pendant type in all locations where piping is concealed above ceilings.

Sprinkler heads shall be standard upright type where piping is installed exposed in warehouse, garage and other locations as indicated on the Drawings. Upright heads shall be plain brass finish.

Sidewall sprinkler heads, where permitted, shall be chrome-plated in finished rooms, plain brass elsewhere.

Flush chrome-plated sprinkler heads shall be installed where noted on the Drawings.

Temperature rating of sprinklers shall be in accordance with requirements of approving authorities and as noted on the Drawings.

Sprinkler heads shall be installed centered in the ceiling tile where applicable. Three locations are acceptable in 2 foot by 4 foot ceiling tiles.

Sprinkler heads installed in areas where damage may occur, such as gymnasiums, shall have head guards.

1.10 WATER FLOW SWITCHES AND ALARMS:

Flow switches for alarm bell shall be furnished, installed and wired by this Contractor. This Contractor shall also furnish, install and wire an exterior sprinkler alarm bell.

The Division 26 Contractor will make one power connection to the sprinkler alarm system. All other wiring shall be furnished and installed by this Contractor.

The Contractor shall also furnish and install the required tamper switches and zone flow switches to be wired to the fire alarm system by DIVISION 26.

1.11 DRAINS:

Main system drain shall be piped to sewer connection or through wall of building to atmosphere where properly trapped sewer connection is not available. Auxiliary drains shall be piped to floor drain where practical or valved and plugged.

1.12 SIAMESE FIRE DEPARTMENT CONNECTION:

The location of the Fire Department Connection shall be in accordance with Sioux Falls Fire Department requirements.

Furnish and install a Potter Roemer Series 5020 or equal Siamese connection where shown on the Drawings. Wall plate shall read "AUTOMATIC SPRINKLER." Finish shall be polished brass. Inlets shall be 2-1/2 inch size and outlet shall be 4 inch size. Install an automatic ball drips between the Siamese connection and the check valve.

Siamese connections shall have polished brass caps and chains. Locking Fire Department connection caps shall be provided where required by the fire code official and where the responding fire department carries appropriate key wrenches for removal. Outlets shall be 36 inches above finished grade. Threads for Fire Department connections shall be National Standard. Verify threads and cap type with the local Fire Department.

Fire Department connections shall be Potter Roemer, Central, Seco and Elkhart, or equal.

1.13 DOUBLE CHECK BACKFLOW PREVENTER:

Furnish and install Watts Regulator Co., series No. 007-S, 709-S or equal double check backflow preventers where shown. The backflow preventer shall be a complete assembly including tight closing shut-off valves before and after the device and also be protected by a strainer. It shall be a complete assembly including four ball type test cocks.

The device shall meet the requirements of A.S.S.E. standard 1015 and A.W.W.A. standard C506.

Double Check Backflow Preventer shall be Ames, Watts, Hersey, Conbraco, Febco, Wilkins or equal.

END OF SECTION 210500

DIVISION 22 – PLUMBING AND HEATING

SECTION 220100 - GENERAL PROVISIONS

1.01 SCOPE:

The GENERAL, SUPPLEMENTAL and other CONDITIONS of the Contract and the GENERAL REQUIREMENTS (Division 1) are hereby made part of this Section.

This Section pertains to general provisions and requirements for construction of work specified in all sections of Division 22 herein.

"Contractor" referred to in this Section of the specification implies the Contractor, Subcontractor and/or Subcontractors which are responsible for all or any part of the mechanical installation specified in Division 22 and/or as shown on the Contract Drawings.

Where the specifications in subsequent Sections of Division 22 conflict with requirements of this Section, the specifications in the subsequent Sections shall govern.

The Contractor shall provide all items, articles, materials, operations or methods listed, mentioned or scheduled on the Drawings and/or herein specified, including all labor, materials, equipment, accessories, wiring and incidentals necessary to be installed in accordance with manufacturer's recommendations except as otherwise approved.

1.02 PERMITS AND SERVICE CHARGES:

All permits and service charges necessary for execution of the work under this Contract shall be obtained by and be paid for by the Contractor. It shall be the responsibility of the Contractor to determine the permit requirements of the local authorities and utility companies and the cost of required permits, service charges, tap fees and development fees shall be included in the Contractor's bid.

All work shall be executed in accordance with all local, state and national rules, regulations, codes, etc., which are applicable and shall be subject to inspection by the proper authorities.

1.03 CODES AND STANDARDS:

All work performed and all equipment furnished under this Division of the Contract shall be manufactured and installed in strict accordance with all applicable codes and standards, including the applicable provisions of the following codes and standards.

1. Local and State Codes, Standards and Regulations.
2. National Fire Protection Association (NFPA).
3. National Electric Code (NEC).
4. Underwriter's Laboratory (UL).
5. American Gas Association (AGA) Standards.
6. Uniform Plumbing Code.
7. International Mechanical Code.
8. ASME Boiler and Pressure Vessel Codes.
9. State Boiler Safety Code.

10. American Waterworks Association (AWWA).
11. National Sanitation Foundation (NSF).
12. Williams-Steiger Occupational Safety and Health Act of 1970 (OSHA).
13. International Building Code.
14. Life Safety Code.
15. State Energy Conservation Standards.
16. Americans with Disabilities Act (ADA).

All materials installed shall have composite fire and smoke hazard ratings as tested by procedures ASTM 84, NFPA 255 and UL 723 not to exceed 25 Flame Spread and 50 Smoke Developed.

1.04 COMPLIANCE:

Where specific requirements of any code vary with the requirements of another code, the higher standard as determined by the Architect/Engineer shall govern the installation.

All equipment manufactured in accordance with the provisions of the above codes and standards shall bear the label of the respective association bureau thereon.

1.05 DRAWINGS:

In general, the Drawings of the mechanical systems and equipment are to scale. However, to determine exact locations of walls and partitions, the Contractor shall consult the architectural and/or structural drawings which are dimensioned. Drawings shall not take precedence over field measurements.

Drawings of piping and ductwork, although shown on scale drawings, are diagrammatic only. They are intended to indicate size and/or capacity where stipulated, approximate location and/or direction, and approximate general arrangement of one phase of work to another, but not the exact detail or exact arrangement of construction. If it is found, before installation of any or all construction phases, that a more convenient, suitable or workable arrangement of any or all phases of the project would result by varying or altering the arrangement indicated on the Drawings, the Architect/Engineer may require the Contractor to change the location or arrangement of the work without additional cost to the Owner. Such rearrangement shall be in accordance with directions from the Architect/Engineer.

Where discrepancies are discovered after certain portions or phases of the work have been installed, the Architect/Engineer reserves the right to require the Contractor to make changes in pipe, duct, fixture or equipment locations or arrangements to avoid conflicts with work at no additional cost to the Owner.

Because the Drawings are to a relatively small scale to show as large a portion as is practical, the fact that only certain features of the system are indicated does not mean that other similar or different features or details will not be required. The Contractor shall furnish all incidental labor, material or equipment for the systems so that each system is a complete and operating one unless otherwise specifically stipulated in the detailed body of the specifications.

The Contractor, Subcontractor's and their respective trades shall cooperate in laying out their work so it will fit properly into the space provided. Promptly report to the Architect/Engineer any delay or difficulties encountered in the installation of this work which might prevent prompt and proper

installation, or make it unsuitable to connect with or receive the work of others. Failure to so report shall constitute an acceptance of the work of other trades as being fit and proper for the execution of this work.

1.06 SUBSTITUTIONS AND PRODUCT OPTIONS:

The Contractor and equipment suppliers shall read and familiarize themselves with articles concerning substitution of materials, as indicated in the Instructions to Bidders. Material and equipment substitutions will be handled as follows:

Materials or equipment specified by name of manufacturer, brand, trade name or catalog reference, shall be furnished under the contract unless changed by Addenda or a Contract modification. Where two (2) or more materials are named, the choice of these shall be optional with the Contractor.

Material or equipment followed by the phrase "or equal" shall establish a standard of required function, dimension, appearance and quality to be met by any proposed substitute. No substitution will be considered unless written request for substitution has been submitted by the bidder and has been received by the Architect/Engineer at least ten days prior to the date for receipt of bids. The Architect/Engineer's decision on a proposed substitute shall be final. If the Architect/Engineer considers any proposed substitution equal, such will be set forth in an Addendum. Bidders shall not rely upon substitutions made in any other manner.

Should the Contractor wish to use materials or equipment other than those specified or listed as equal by Addenda, he shall attach his proposed substitution along with the appropriate add or deduct to the Contract amount, should the substitution be accepted. Substitutions proposed by the Contractor will not be considered in the award of the Contract.

1.07 SHOP DRAWINGS:

Refer to the requirements of the General Conditions. Unless indicated otherwise in the General Conditions, submit to the Architect/Engineer seven (7) copies (minimum) of Shop Drawings for each item of equipment to be installed under this contract with two (2) copies to be retained by the Architect/Engineer. Furnish additional Shop Drawings as required for coordination with General Contractor and other Subcontractors.

To the extent practical, complete sets of shop drawings for each specification section shall be submitted. In the case that a particular item is required to be expedited, that particular item may be submitted individually.

Submit shop drawings punched in 3-hole format.

Furnish Shop Drawings as follows:

1. For all major items of equipment or materials, regardless of whether the item is to be furnished as specified.
2. For all equipment, systems or devices where Shop Drawings are specifically called for.
3. For all minor items of equipment or materials where the Contractor proposes to deviate from the specified and/or scheduled manufacturer or material.

The Contractor shall check all Shop Drawing submittals for size, capacity, arrangement, connection locations, materials, finish, color, electrical characteristics, accessories, and shall so note the Shop Drawings prior to submittal to the Architect/Engineer. Any deviation from the Drawings and Specifications shall be indicated.

Shop Drawings will be reviewed by the Architect/Engineer, and copies of Shop Drawings will be returned to the Contractor. Shop Drawings shall be submitted sufficiently in advance of the construction schedule to allow time for checking Drawings, resubmittal and rechecking when necessary.

Any equipment or material which is installed without authorization by properly processed Shop Drawings will be subject to removal by the Contractor and reinstallation as directed, without cost to the Owner. All cost for repair for damages as may be incurred to the structure as a result of the above correction shall be paid by this Contractor.

Shop drawing material quantities will not be checked by the Architect/Engineer, and review of Shop Drawings by the Architect/Engineer shall not be construed to be verification of the material quantities and sizes shown on the Shop Drawings. Quantities, sizes, dimensions and locations shown on the Drawings and as specified shall determine material requirements.

1.08 CLEANING:

The Contractor and/or Subcontractors for the various phases of the work shall clear away all debris, surplus materials, etc., resulting from their work or operations, leaving the job and equipment furnished under any or all contracts in a clean first class condition.

Permanent heating and ventilating systems shall not be used during the construction period unless the project site is in a clean and dust free condition and shall be subject to the approval of the Architect/Engineer and Owner.

Air surfaces of all coils, heaters, boilers, pumps and mechanical equipment shall be wiped clean or washed if required, leaving the installation in a first class condition. All throwaway filters used during construction shall be replaced.

All plumbing fixtures shall be thoroughly cleaned of all plaster, stickers, rust stains, and other foreign matter or discoloration, leaving every part in a first class condition and ready for use. The surfaces of all floor drains, cleanouts and other equipment shall be cleaned, and each item shall be left in a first class condition.

1.09 PAINTING:

Painting of materials and equipment furnished under the mechanical portion of the contract shall be as described in Division 9 - FINISHES. Contractor shall refinish and restore to the original condition and appearance, all mechanical equipment which has sustained damage to the manufacturer's prime and finish coats of enamel or paint. Materials and workmanship shall be equal to the requirements described in Division 9 - FINISHES.

1.10 RECORD DRAWINGS:

The Contractor shall keep a complete set of all mechanical drawings in the jobsite office for purpose of showing the installation of mechanical systems and equipment. This set of drawings shall be used for no other purpose. Where any materials equipment or system components are installed different from that shown on the Architect/Engineer's drawings, such differences shall be clearly and neatly shown on this set of drawings using ink or indelible pencil. At the completion of the project, the record set of drawings shall be turned over to the Architect/Engineer and shall become his property.

1.11 STERILIZATION OF WATER SUPPLY SYSTEM:

All domestic water and site irrigation systems shall be sterilized with sufficient chlorine to provide a dosage of not less than 200 ppm with a contact period of not less than 3 hours, and with all valves in line opened and closed at least three times during the sterilized period. Following the contact period, the water is to be thoroughly flushed from the system until the residual chlorine content is not more than 0.20 ppm.

A certificate of completion shall be provided.

1.12 OPERATING INSTRUCTIONS:

The Contractor shall furnish the Owner two (2) sets of complete catalog data, manufacturer's literature and detailed manuals covering the operation and maintenance of all equipment specified under this Division. All such literature shall be bound in an amply sized three-ring binder and submitted to the Architect/Engineer for approval and for eventual transmittal to the Owner. The manual shall have a Table of Contents at the front of the manual.

The Contractor shall also supervise the initial operation of all equipment and instruct the operator selected by the Owner in such operation as required to acquaint him thoroughly with the equipment.

1.13 DELIVERY AND STORAGE OF MATERIALS:

Make provisions for delivery and safe storage of materials on the jobsite and make arrangements with other Contractors for introduction into the building of equipment too large to pass through finished openings. Materials to be delivered at such stages of the work as will expedite the work as a whole and marked and stored in such a way as to be easily checked and inspected. All stored equipment shall be protected from the weather conditions and construction debris with a protective covering securely tied in place.

1.14 MECHANICAL PROVISIONS:

Mechanical equipment shall operate without objectionable noise or vibration, as determined by the Architect/Engineer. If such noise or vibration should be produced and transmitted to occupied portions of the building by apparatus, piping, or other parts of the mechanical work, make necessary changes and additions, as approved, without extra cost to Owner.

Provide oil level gauges, grease cups and grease gun fittings for machinery bearings as recommended by the manufacturer. Extend oil or grease fittings by copper tubing to readily accessible locations.

1.15 CONCRETE BASES:

Concrete bases are required for floor mounted mechanical equipment inside buildings and are specified in Division 3 - CONCRETE. After bases are poured they shall set at least seven (7) days before mounting equipment. The Contractor shall coordinate the setting of expansion bolts in the bases for attachment of equipment and/or isolators.

This Contractor shall verify and coordinate the exact location of the bases and the exact size requirements for specific items of equipment.

Water heaters, water softeners, air compressors, vacuum pumps, boilers, pumps, tanks, indoor chillers and condensers and other floor mounted mechanical equipment shall be mounted on four inch (or as required) high concrete bases.

1.16 COORDINATION OF WORK:

The Contractor shall process shop drawings and order equipment and materials expeditiously after receiving the Contract and the mechanical installation shall be substantially complete when the general construction work is completed. This Contractor shall confer and cooperate with all other Contractors on this project and shall arrange his work in proper relation to the work of others. Each Contractor shall furnish, install, and maintain in place all anchors, inserts, sleeves, etc., required for his work. Each Contractor will also be held solely responsible for proper size and location of all anchors, inserts, sleeves, chases, recesses, openings, bases, etc., required for proper installation of his work. All cutting and patching made necessary by failure or neglect to coordinate with other Contractors shall be the responsibility of this Contractor. Any cutting or patching shall be subject to the direction and approval of the Architect/Engineer and all damage due to cutting or patching shall be repaired by this Contractor.

After being instructed by this Contractor to do so, the General Contractor will leave all openings in roof, walls, floors, etc., for the passage of pipes, etc. The General Contractor shall also provide concrete bases and roof curbs where shown for mounting the mechanical equipment unless specified otherwise. This Contractor shall verify the exact size and location required for installation of his equipment with the General Contractor.

In general, the Division 26 – Electrical Contractor will provide all power wiring and make one power connection to each item of mechanical equipment, as outlined under Electrical Section.

1.17 GUARANTEE:

Refer to the requirements of the General Conditions of the Contract for Construction.

All mechanical equipment including equipment used during construction for temporary purposes shall be guaranteed for a period of one year after the time of final acceptance of this work and shall be in like new condition at time of final acceptance.

1.18 TEMPORARY HEAT:

Refer to the requirements of the General Conditions of the Contract for Construction.

The building heating systems shall not be used for temporary heating purposes without written approval of the Architect/Engineer.

Use of the building permanent heating systems prior to substantial completion is subject to the written approval of the Architect/Engineer and extended warranties shall be provided at no additional cost.

1.19 ELECTRICAL:

Electric Motors:

All electric motor driven equipment being furnished and installed under Division 22 of these specifications shall be complete with electric motors, unless specified otherwise.

All electric motors shall be as manufactured by Westinghouse, Century, Wagner, Allis Chalmers, Reliance, General Electric, or equal. Bearings shall be ball type with alemite lubricating fittings extended to an easily accessible location for field servicing. Minimum service factors for all motors shall be 1.15. All motors shall conform to applicable NEMA standards and all motors specified for use in hazardous locations shall bear the stamp of approval of the Underwriter's Laboratories. All motors, except direct connected motors, shall be furnished complete with cast iron or stamped steel adjustable slide rails. Single phase motors shall be capacitor start type, drip proof, unless specified otherwise. All motors shall be single speed and shall operate at 1,750 RPM, unless specified otherwise.

Horsepower Rating: All electric motors shall be sized to meet the horsepower requirements of the driven unit at design characteristics including all V-belt and/or drive and coupling losses which are incurred without loading the motor beyond its nameplate horsepower rating. Where V-belt drives are employed, the motor horsepower nameplate ratings shall not be less than 120 percent of the driven unit brake horsepower requirements.

Single Phase Motors: Unless specifically noted otherwise, all electric motors shall be designed for operation in an ambient temperature not exceeding 40 degrees C., continuous duty and shall be designed for use with voltage as scheduled on Drawings or specified, 60 cycle alternating current. Motors shall be thermally protected.

Three Phase Motors: All electric motors shall be designed for operating in an ambient temperature not exceeding 40 degrees C., continuous duty and shall be designed for use with voltage as scheduled on Drawings or specified, 60 cycle alternating current.

All motors less than 3/4 horsepower shall be 115 volt, single phase unless designated otherwise and all motors 3/4 horsepower and larger shall be as specified in the specific section or as noted on the Drawings.

Two Speed Motors:

Two speed motors shall have two separate windings.

Premium Efficiency Motors:

Premium efficiency motors shall be furnished on all mechanical equipment where 1 horsepower or larger motors are required.

Motors shall be designed with special stator steel for reduced core losses. Windings shall be oversized copper placed for maximum efficiency. Stator and rotor shall be extra long to reduce flux losses. Frame shall be ODP (unless specified otherwise) of cast iron or cast aluminum construction.

Motors shall be squirrel cage, horizontal base mount, ball bearing, NEMA B design, Class B design, Class B insulation, continuous duty, 1.15 SF, 40 degrees C. ambient.

Minimum nominal full load motor efficiencies shall be based on ASHRAE Standard 90 (latest edition).

Furnish and install Aegis SGR, or equal, maintenance free, circumferential, conductive micro fiber shaft grounding rings on all AC motors controlled by adjustable frequency drives to discharge shaft currents to ground.

Motors shall be similar to Louis Allis "Spartan" Series, Gould "E-Plus" Series, or Westinghouse "MAC II" Series. Manufacturer shall furnish proof of efficiency rating.

Motor Starters:

Except where specifically described as being furnished as a part of the equipment furnished and installed under Division 22 of these specifications, all motor starters will be furnished and installed under Division 26, ELECTRICAL.

Electrical Wiring:

Except where specifically described as being furnished as a part of the equipment furnished and installed under Division 22, all electric power wiring shall be furnished and installed in Division 26, ELECTRICAL. The Electrical Contractor will make one power connection to each item of mechanical equipment, unless specified otherwise.

Electrical wiring furnished and installed under these specifications shall conform to all applicable requirements of Division 26, ELECTRICAL.

Unless otherwise indicated, all motors and controls shall be furnished, set in place and wired in accordance with the following schedule:

Item	Division Furnished Under	Set in Place or Mounted Under	Division Wired & Connected Under
Equipment Motors	22	22	26

Magnetic Motor Starters:			
Automatically controlled, with or without HOA switches	26	26	26
Automatically controlled, with or without HOA switches and furnished as part of factory wired equipment	22	22	26
Manually controlled	26	26	26
Manually controlled and furnished as part of factory wired equipment	22	22	26
Line voltage thermostats, time clocks, etc., not connected to control panel systems	22	26	26
Electric thermostats, time clocks, remote bulb thermostats, motor valves, float controls, etc., which are an integral part or directly attached to ducts, pipes, etc.	22	22	22
Temperature control panels and time switches mounted on temperature control panels	22	22	22
Motor valves, solenoid valves, EP and PE switches, etc.	22	22	22
Alarm bells	22	22	22

Control circuit feeders	26	26	26
Low voltage controls, thermostats, valves, etc.	22	22	22
Fire protection controls	22	22	26
Fire and smoke Detectors	26	26	26(1)
Pushbutton stations, pilot lights	26	26	26
Heat tape	26	26	26
Disconnect switches, thermal overload switches, manual operating switches	26	26	26
Multi-speed switches	22	26	26
Contactors	26	26	26
Control relays, transformers	22	26	26

NOTES:

(1) Wiring from alarm contacts to alarm system shall be by the Division 26 Contractor; control function wiring shall be by the Division 22 Contractor.

All control wiring and controls as noted on the Drawings and/or as specified in these specifications shall be provided by this Contractor, including items set in place and wired and connected by the Division 26 Contractor, unless specifically shown otherwise on the Drawings.

1.20 SLEEVES:

Any pipe passing through building construction including walls, floors, roofs or masonry partitions or as noted on the Drawings shall be encompassed with sleeves in accordance with the following:

All pipe sleeves through slabs, floors, masonry walls and masonry partitions shall be 1/2 inch greater in inside diameter than the external diameter of pipe passing through. Sleeves for insulated piping shall be large enough to accommodate the insulation without harming the insulation or vapor barrier. All sleeves shall be fabricated from new material cut square and reamed.

Sleeves shall be provided in all masonry partition walls including locations above suspended ceilings where masonry partition walls extend from floor slab to slab above. Sleeves shall be Schedule 40 steel pipe finishing flush with the wall surface.

Sleeves through exterior building walls shall be Schedule 40 steel pipe with welded flange in the middle of the sleeve and ends finishing flush with finished surfaces. Space between pipe and sleeve shall be packed to provide a watertight joint.

Sleeves through roof slabs and floor slabs in concealed locations shall be No. 22 gauge galvanized steel or crete sleeves (linear polyethylene). Concealed sleeves shall be considered as pipe sleeves in shafts, pipe chases and within walls and partitions.

Sleeves through floor slabs in exposed areas shall be Schedule 40 steel pipe and sleeves shall extend 1/4 inch above the finished floor surface. For slabs in equipment rooms and in other wet areas, sleeves shall be Schedule 40 steel pipe and shall extend 2 inches above finished floor surface.

Floor sleeves in membraned floors shall be furnished with flashing rings and clamps.

All sleeves in exposed locations, except equipment rooms, shall be set so plates specified will cover the sleeves.

All pipe sleeves where wet conditions exist, except sleeves through exterior walls, shall be caulked with a plastic caulking, including sleeves in concealed locations. The space between the pipe and the sleeves shall be packed with oakum and approximately 1/2 inch depth of a polyisobutylene sealer shall be packed or caulked in both ends of sleeve, even with the ends of the sleeve. The sealer shall be suitable for temperatures from minus 50 degrees to 300 degrees, suitable for painting, non-corrosive and have good adhesion.

Sleeves in fire rated construction, equipment rooms, and/or where designated on the Drawings shall consist of 22 gauge galvanized sheet steel with lock seam joints. Seal sleeves with a fire retardant sealant. When applied according to manufacturer's recommendations, sealant shall have a 3-hour U.L. fire rating.

All sleeves required to provide the proper openings in masonry construction for the passage of ductwork, mechanical equipment, etc., shall be furnished and installed by this Contractor. These sleeves shall also be removed by this Contractor after the opening has been formed. The opening around all ductwork, equipment, etc., passing through slabs, floors, walls and partitions shall be sealed as specified above for piping. Fire/smoke dampers shall be installed in accordance with the manufacturer’s installation instructions.

All sleeves shall be set and maintained in place by this Contractor during the progress of the work. This Contractor shall be responsible for locating all sleeves at the proper location.

Sleeves are not required for core drilled masonry wall and floor holes, masonry wall and floor holes formed by polyethylene plastic (removable) sleeves, or for masonry holes made in another neat manner except in equipment rooms and other wet areas.

Sleeves are not required in metal or wood stud wall construction. Rated systems shall be provided as required to provide the necessary rating of the penetration.

Interior wall sleeves are only required on cold insulated piping (cold water, downspout, chilled water supply and return, etc.). All other steel or cast iron piping 4 inches and smaller shall be grouted directly into the wall as necessary to provide the required fire and smoke rating. Piping larger than 4 inch size and all non-rated piping shall be provided with a rated system.

Firestopping materials shall be 3M, Hilti, MetaCaulk, Nelson or equal.

1.21 WALL, FLOOR AND CEILING PLATES:

Furnish and install chrome-plated wall, floor and ceiling plates on all exposed pipes where they pass through walls, floors, or ceilings in finished areas. Finished areas shall be those areas which are painted or have special finishes within the room. The wall plates shall be a minimum of 3/32 inch thickness and shall have set screws or spring locks for clamping to the piping. Flush valves shall have set screw type wall plates. The plates shall be chrome-plated steel, cast iron or brass and shall set tight against the wall.

1.22 EQUIPMENT SUPPORT:

Furnish and install all necessary wall backing, brackets, braces, plates, angles, closet carriers, lavatory carriers, urinal carriers, wall hangers, etc., required for properly supporting plumbing fixtures, mechanical equipment and mechanical appurtenances. All supports shall be securely anchored with lead inserts, expansion shields, through-going bolts, lag screws or other devices as required.

All items of mechanical equipment hung from overhead structure shall be hung from 2-1/2 inches by 2-1/2 inches by 3/16 inch angles minimum which shall span at least 3 members, unless noted otherwise.

1.23 EXISTING SERVICES:

The Contractor shall verify the exact location of all existing building services extended and/or relocated for this project. The Contractor shall also verify the exact location and take proper precautions to protect all services which may be encountered during construction.

All active services which are encountered shall be protected, braced and supported where required for proper execution of the work and without interruption of the service if possible.

All inactive services which are encountered shall be protected or removed as directed by the Architect/Engineer, Owner, Utility Company or Municipal Agency having jurisdiction. The service shall also be plugged or capped as directed.

When active services must be temporarily interrupted, the interruption shall be scheduled at night or at such time as approved by the Owner or authority having jurisdiction and so as to cause the minimum of interference with establishing operating routine. Arrangements shall be made to work continuously including overtime if required, to assure that services will be interrupted only as long as actually required to complete necessary work.

1.24 EXCAVATION:

Trenching and excavation for all underground piping and equipment shall be excavated to the required depths. The bottom of the excavation shall be tamped hard and graded to secure the required fill. Bell holes shall be excavated so that pipe will rest on solid ground for its entire length. Rock, where encountered, shall be excavated to a depth of 6 inches below the bottom of pipe and before pipe is laid, the space between bottom of pipe and rock surface shall be filled with gravel. Sewer and water pipes shall be laid in separate trenches, except where otherwise noted and in accordance with applicable codes.

After the piping and equipment have been tested, inspected and approved by the Architect/Engineer and prior to the backfilling, forms shall be removed and the excavation shall be cleaned of trash and debris. Materials for backfilling shall consist of the excavation, or borrow of sand or gravel, and shall be free of trash, lumber, or other debris. Backfill shall be placed in horizontal layers, not exceeding 9 inches in thickness, and properly moistened. Backfill inside the building and under any exterior slabs or other paved areas shall be compacted by hand or mechanical means to the density of 95 percent Proctor and areas outside the building not covered by concrete slabs or other structures or pavement shall be compacted to the density of the adjacent undisturbed soil. Any settling within the one (1) year guarantee period shall be repaired at no cost to the Owner.

1.25 ACCESS TO EQUIPMENT:

Access shall be provided to all motors, valves, controls, specialties, etc., for maintenance purposes. All access doors, access panels, removable sections, etc., required for access shall be provided. The location of the access openings relative to the mechanical equipment shall be coordinated to assure proper access to the equipment. The door shall maintain any ratings of the wall, ceiling, etc. that it penetrates.

Access openings are required for valves and other devices requiring access and shall be provided in the ductwork, plenums, housings, tanks, walls, ceilings, etc., under this portion of the Contract.

1.26 PROTECTIVE DEVICES:

All sheaves, belts, drives, couplings, and moving parts shall be protected by approved permanent guards, shields, or railings, which shall be in place whenever the equipment is in operation and shall be in accordance with applicable safety standards.

All pressure and/or temperature relief valves shall have the discharge piped full size to within 6 inches of the floor or floor drain. The piping shall be securely anchored. All relief valves shall be ASME approved and proper size for the application.

1.27 PIPE AND PIPE FITTINGS:

Furnish and install where shown on the Drawings and required to connect fixtures and equipment, pipe and fittings of type and material for the various services as noted below. At all exposed fixture supply connections, nipples are required between copper tubing and fixtures, such nipples shall be standard weight full iron pipe size chrome-plated brass pipe nipples with suitable brass or copper adapters. Steel or iron nipples will not be permitted in any location in copper lines where connections are made to brass fixtures, valves or trim. Compression stops may be used when fitted

tight against the wall escutcheon with no exposed copper piping. Sweat adapters and chrome plated cover tubes may be used when the cover tube extends the entire pipe from the elbow in the wall or chase to the flush valve and fits tight.

Piping that is not shown on the Drawings, which is obviously necessary for complete systems, shall be provided and shall be amply sized in accordance with applicable codes and standards.

All welding fittings shall be Tube Turn, Taylor Forge, B & W, Ladish Yoloy, or equal.

The Contractor may use a mechanically formed tee fitting as manufactured by T-Drill or equal. All joints created in this manner shall be installed and brazed in compliance with Plumbing Codes and the manufacturer's recommendation. Soft soldered joints are not allowed in mechanically formed tee fitting installations. The branch tube shall be notched and contain a double dimple. The first to insure proper penetration into the main line. The second dimple (1/4" above the first) will serve as a visual inspection point.

Grooved pipe fittings, valves and couplings shall be Victaulic, Anvil Gruvlok, Central Sprink, Star or equal. All components shall be supplied by one manufacturer.

Underground steel piping systems shall be coated with asphaltum or bituminous paper for corrosion protection.

Plastic piping shall not be used in air plenums or in buildings classified as noncombustible construction.

The piping for the various systems shall be as follows:

Cold, hot and recirculating hot water in buildings above ground, 3 inches and smaller shall be Type L, hard drawn copper tubing, ASTM B88 and Federal Specification WW-T-799. Fittings shall be wrought copper solder type, ANSI B16.22. Joints for pipe and fittings shall be made with No. 95-5 (tin-antimony) solder and No. 50 non-corrosive flux.

Water in buildings underground shall be ductile iron or Type K copper. The ductile iron shall be AWWA ductile iron, bell and spigot, Class B water pipe with fittings being Class D ductile iron AWWA bell and spigot coated with asphaltum and/or Class 150 C.I. mechanical joints, Federal Specification WW-P-421 with rubber gaskets. The copper shall be Type K soft drawn copper, ASTM B88 and Federal Specification WW-T-799 with wrought copper solder fittings, ANSI B16.22. Joints for pipe and fittings shall be made with No. 95-5 (tin-antimony) solder and No. 50 non-corrosive flux.

Soil, waste, rainwater and vent piping in buildings underground shall be cast iron, ABS or PVC plastic.

Piping may be service weight cast iron soil pipe, Federal Specification WW-P-401 hub and spigot to 5 feet outside building walls, coated with asphaltum. Fittings shall be cast iron hub and spigot, coated with asphaltum. Piping may be hubless cast iron pipe and fittings.

Where codes permit, piping may be ABS or PVC Schedule 40 plastic piping and fittings. ABS piping and fittings shall meet ASTM D2661-68. PVC piping and fittings shall meet ASTM D2665-68 and Federal Specification L-P-320.

Soil, waste, rainwater and vent piping in building, above ground shall be galvanized steel, cast iron, ABS or PVC plastic, or DWV copper as follows:

Piping may be galvanized steel pipe, ASTM A120, Federal Specification WW-P-406, Schedule 40, screwed. After assembly of pipe and fittings, paint visible threads with aluminum paint. Fittings shall be standard weight, black cast iron (galvanized cast iron where required by code), screwed. For waste, soil, and rainwater piping, drainage type (Durham) fittings of long pattern shall be used. For rainwater piping the Contractor may use grooved galvanized steel pipe, grooved fittings and mechanical couplings by written request to the Architect/Engineer including evidence that governing codes permit its use and naming the material manufacturer, pressure rating and other pertinent data.

Piping may be standard weight screwed, or hubless cast iron pipe and fittings. If screwed cast iron is used, threads shall be painted after assembly.

Where codes permit, piping may be ABS or PVC Schedule 40 plastic piping and fittings. ABS piping and fittings shall meet ASTM D2661-68. PVC piping and fittings shall meet ASTM D2665-68 and Federal Specification L-P-320.

Where codes permit, piping may be hard drawn, DWV copper, ASTM B306. Fittings shall be cast red bronze and wrought copper DWV incorporating 1/4 inch per foot drainage pitch. Joints for pipe and fittings shall be made with No. 50-50 solder and No. 50 non-corrosive flux.

For 2 inch and larger pipe, piping may be standard weight, cast iron, hub and spigot soil pipe, Federal Specification WW-P-401. For 1-1/2 inch and smaller pipe, Schedule 40, galvanized steel, ASTM A120 and Federal Specification WW-P-406. Fittings for hub and spigot shall be long pattern. For 1-1/2 inch and smaller fittings shall be black cast iron, screwed, drainage fittings (Durham) long pattern. Hub and spigot joints shall be preformed molded rubber rings where codes permit.

For sizes 1-1/2 inch and smaller, piping may be Schedule 40, galvanized Yoloy screwed pipe, ASTM A53 and Federal Specification WW-P-404.

Soil, waste, and rainwater piping outside of building shall be ABS or PVC plastic or cast iron pipe (CIP) as follows:

Cast iron pipe shall be service weight soil pipe Federal Specification WW-P-401, coated.

Where codes permit, piping may be ABS or PVC Schedule 40 plastic piping and fittings. ABS piping and fittings shall meet ASTM D2661-68. PVC piping and fittings shall meet ASTM D2665-68 and Federal Specification L-P-320.

Where codes permit, piping may be ABS or PVC type SDR 35 plastic piping and fittings. Piping and fittings shall meet ASTM 3033 and 3034.

Cooling coil condensate drains and louver drains in buildings above ground shall be Type L, hard drawn copper tubing, ASTM B88 and Federal Specification WW-T-799. Fittings shall be wrought copper solder type, ANSI B16.22. Joints for pipe and fittings shall be made with No. 95-5 (tin-antimony) solder and No. 50 non-corrosive flux.

Hot water heating supply and return and chilled water supply and return shall be Schedule 40 black steel or copper pipe as follows:

Schedule 40 black steel pipe shall conform to ASTM A120/ASTM A53 and Federal Specification WW-P-406, Weight A. Sizes 2 inch and smaller shall have screwed ends. Sizes 2-1/2 inch and larger shall have plain ends for welding. Fittings shall be 125 pound screwed, banded, black cast iron for sizes 2 inch and below, and standard weight welding fittings (use long radius ells) for sizes 2-1/2 inch and larger. Welding flanges shall be used adjacent to equipment and valves. Welding rods as recommended by ASTM Specification A233. Welding rings shall be used at all joints.

The Contractor may use grooved steel pipe, grooved fittings and mechanical couplings as manufactured by Victaulic, Grinnell, Anvil Gruvlok or equal on all systems recommended by the manufacturer. Grooved piping systems including valves, fittings, etc., shall be supplied by only one manufacturer. Grooving tools shall be supplied by the same manufacturer as the grooved components. Grooved fittings shall be ASTM A536 ductile iron or ASTM A53 forged or fabricated carbon steel with grooved ends designed to accept grooved joint couplings of the same manufacturer. Coupling gaskets shall be Grade EPDM suitable for hot water systems up to 250 deg F. Rigid style coupling housings shall be cast with offsetting, angle-pattern bolt pads to provide system rigidity. Flexible style couplings shall be installed where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors for vibration isolation at equipment connections. Three (3) couplings, for each connection, shall be placed in close proximity to the source of the vibration.

Copper piping shall be hard drawn Type L copper tubing, ASTM B88 and Federal Specification WW-T-799. Fittings shall be wrought copper solder type, ANSI B16.22. Joints for pipe and fittings shall be made with No. 95-5 (tin-antimony) solder and No. 50 non-corrosive flux.

The Contractor may use roll grooved copper tubing, grooved fittings and mechanical couplings as manufactured by Victaulic, or equal, on all systems recommended by the manufacturer. Grooved piping systems including valves, fittings, etc., shall be supplied by only one manufacturer. Grooving tools shall be supplied by the same manufacturer as the grooved components. Fittings shall be ASME B16.22 wrought copper or ASME B16.18 bronze casting with copper tube dimensioned grooved ends (flaring of tube and fitting ends to IPS dimensions is not permitted). Housings shall be cast with offsetting, angle pattern bolt pads coated with copper-colored enamel. Gasket shall be Grade EPDM suitable for hot water systems up to 250 deg F.

The grooved coupling manufacturer's factory-trained field representative (direct employee) shall provide on-site training to the Contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. The factory-trained representative shall periodically review product installation. The Contractor shall remove and replace any improperly installed products.

Natural gas piping shall be standard weight black mild steel pipe, ASTM A120/ ASTM A53 and Federal Specification WW-P-406. Fittings for exposed gas piping up to and including 2 inch size shall be standard weight black malleable iron screwed fittings. Fittings 2-1/2 inch size and larger and in all concealed locations shall be welding type. There shall be no unions installed in concealed locations. All underground gas piping shall be welded and shall be wrapped with bituminous paper for corrosion protection. A manual shut-off valve, union, and pressure regulator shall be installed at each item of mechanical equipment with a gas connection. A manual shut-off valve shall be installed at all gas connections.

1.28 VALVES:

Furnish and install valves in piping where so indicated on the Drawings. In addition, shut-off valves shall be provided in piping adjacent to each item of equipment, fixtures, etc., in the branch piping to each toilet group and at the base of all water risers.

All cold water and chilled water valves shall have an extended operator stem and insulation sleeve to accommodate the pipe insulation and vapor barrier.

All gate and globe valves shall be installed with stem in a vertical position wherever possible.

Of the several manufacturers listed, the Contractor is to standardize on one make as much as practical but not to the extent of sacrificing quality listed. Valves shall be Milwaukee, Crane, Powell, Stockham, Walworth, Victaulic, Grinnell, Anvil Gruvlok, Watts, Nibco, Hammond or equal.

The valves designated in the following schedule are fully described in the valve list following this schedule.

Valve Service	Valve Designation
Shut-Off Valves For:	
Cold, Hot and Recirculating Hot Water	
Pipe sizes 2 in. and smaller	V-l
Pipe sizes 2-1/2 in. and larger	V-13
Natural Gas	
Pipe sizes 2 in. and smaller	V-9
Pipe sizes 2-1/2 in. and larger	V-11

Drainage and/or Sump Pump Discharge	
Pipe sizes 2 in. and smaller	V-2
Pipe sizes 2-1/2 in. and larger	V-5 or V-13
Circulating Heating Water and Chilled Water	
Pipe sizes 2 in. and smaller	V-1
Pipe sizes 2-1/2 in. and larger	V-5 or V-13
Duct Mounted Heating Coils	V-1
Unit Heaters, Convectors, Radiation	V-1
Balancing Valves For:	
Recirculating Domestic Hot Water	V-l
Circulating Heating Water and Chilled Water	
Pipe sizes 2 in. and smaller	V-1
Pipe sizes 2-1/2 in. and larger	V-13
Unit Heaters, Convectors, Radiation	V-1
Check Valves For:	
Cold, Hot and Recirculating Hot Water	
Pipe sizes 2 in. and smaller	V-4
Pipe sizes 2-1/2 in. and larger	V-8
Circulating Heating Water	
Pipe sizes 2 in. and smaller	V-4
Pipe sizes 2-1/2 in. and larger	V-8
Drainage Sump Pump	
Pipe sizes 2 in. and smaller	V-4
Pipe sizes 2-1/2 in. and larger	V-8
Chilled Water	V-8

Sampling and Vent Cocks For:

Cooling Coil Air Vent	V-10
Drain Valves	V-14

The following is a list of valves types from which valves for use on this project have been selected. See the valve service schedule preceding this list for types to be used on each service.

(V-1) Ball Valves (Fed. Spec. WW-V-35b,): Bronze body ball valve, conventional port, lever handle, screwed or soldered and teflon seats and stem packing, 150 psi SWP, 400 psi WOG, Milwaukee BA-100 or BA-150, 1/2 inch through 2 inch size. Provide Memory Stop on all valves used for balancing purposes.

(V-2) Gate Valves (Fed. Spec. WW-V-54c, Class A. Type II): Bronze body gate valve, rising stem, solid bronze wedge, screw-in bonnet, threaded or soldered ends, teflon packing, 125 psi SWP, 200 psi WOG, 1/4 inch through 2 inch size, Milwaukee 148 or 149.

(V-4) Bronze Check Valve (Fed. Spec. WW-V-5ld, Class A, Type IV): Bronze check valve, horizontal swing regrinding type, Y-pattern, renewable disc, 125 psi SWP, 200 psi WOG, 1/4 inch through 2 inch size, Milwaukee 509 or 1509.

(V-5) Iron Body Gate Valve (Fed. Spec. WW-V-58a, Class I, Type I): Iron body gate valve, bolted bonnet, outside screw and yoke, solid wedge, flanged bronze rising stem, bronze trim, 125 psi SWP, 200 psi WOG, 2-1/2 inch size and larger, Milwaukee F-2885.

(V-8) Iron Body Check Valve: Iron body swing check valve, bolted bonnet, horizontal swing renewable seat and discs, flanged, bronze trim, 125 psi SWP, 200 psi WOG, 2-1/2 inch size and larger, Milwaukee F-2974.

(V-9) Plug Cock: Bronze body square head cock, screwed, 150 psi 1/8 inch through 2 inch size, Lunkenheimer 454.

(V-10) Drain Cock: Bronze body drain cock, steel handle, 125 psi SWP 1/8 inch through 1/2 inch size, Lunkenheimer 476 or 981.

(V-11) Lubricated Plug Valve: Semi-steel body lubricated plug valve, wrench operated, 100 percent area, rectangular port, screwed or flanged, teflon stem seal, natural gas service, 125 psi SWP, 150 psi WOG, Homestead 602.

(V-13) Butterfly Valve: Wafer or lug type iron body butterfly valve, extended neck, stainless steel shaft, bronze disc, EPT seal and seal with 275 degrees F. temperature rating, lever operated up through 6 inch valve size and gear and crank operator over 6 inch valve size, 150 psi WOG, 2-1/2 inch size and larger Milwaukee "M" series.

(V-14) Drain Valve: Bronze body globe valve, screw-in bonnet, integral seat, renewable discs, 1/8 inch through 2 inch size, Milwaukee 502 or 1502.

1.29 PIPING CONNECTIONS:

Furnish and install unions or mating flanges at all connections to each piece of equipment, conveniently located to facilitate quick and easy disconnecting of equipment for replacement, tube cleaning or general maintenance. Flanged or union connections shall be used on both sides of equipment connections, control valves, pressure reducing valves, meters, tanks, pumps and the like. Unions or flanges shall be of the same material or finish as the piping systems in which they are installed. Unions are not required for grooved pipe systems.

Dielectric unions, flanges, or waterways shall be installed in domestic hot, cold and recirculating water lines where copper or brass piping is connected to ferrous material such as steel piping, steel tanks, steel water heater, etc. Dielectric unions 2 inch size and smaller shall be steel body and nut with insulating gasket and copper connector, 250 psi rating at 190 degrees F., EBCO Model FX, FB, or EA. For 2-1/2 inch size and larger, the union shall be flanges, cast iron with insulated gasket and copper connector, 175 psi rating at 190 degrees F., EBCO Model GX or GA.

Grooved pipe and mechanical joint couplings may be utilized in certain piping systems with Architect/Engineer approval. See section on pipe and pipe fittings.

1.30 FLEXIBLE CONNECTORS:

Furnish and install flexible connectors on all piping connections to rotating equipment such as pumps, compressors, blowers, chillers, condensing units, etc., and where shown on the Drawings. Flexible connectors shall also be installed at all locations where necessary to prevent damaging stresses to piping, equipment, or building structure, and where necessary to isolate noise at its source.

Flexible connectors for chillers, heating and cooling pumps etc., shall be Kinetics noise control type UTC or FTC or equal double sphere molded neoprene, reinforced with nylon tire cord and shall have mild steel floating flanges or threaded ends. The connectors shall be rated for 150 psig at 220 degrees F. Control rods shall be used on 12 inch and larger sizes operating above 100 psig.

Flexible connectors for refrigerant piping shall be close pitch annular corrugated phosphor bronze hose and bronze braid for refrigerant piping and non-ferrous piping systems, Flexonics Type PCB or equal.

Flexible connectors shall be installed in strict accordance with manufacturer's recommendations and shall be constructed of material specified herein, unless recommended otherwise by the manufacturer for specific applications. All piping shall be anchored to prevent elongation or compression of the flexible connectors.

Flexible Connectors shall be Kinetics, Proco, Mercer, Flexonics, Twin City Hose, Inc. or equal.

1.31 PIPE HANGERS, SUPPORTS AND ANCHORS:

Anchors as shown and detailed on the Drawings and specified herein and/or as required. All support components shall conform to Manufacturer's Standardization Society Specification SP-58. The hangers shall adequately support the piping system. They shall be located near or at changes in piping direction

and at concentrated loads. They shall provide vertical adjustment to maintain pitch required for proper drainage. They shall allow for expansion and contraction of the piping. On other than vapor barrier insulated lines, hangers shall bear directly on piping.

Hangers shall be constructed of malleable or wrought iron unless noted otherwise, and hangers supporting copper pipe shall be copper plated. Hangers for pipe 3 inches and smaller shall be band and socket Michigan Model No. 100 or equal. For piping over 3 inches, hangers shall be adjustable, Clevis type, Michigan Model No. 400 or equal.

Where groups of three or more pipes occur, they may be supported with trapeze hangers using two hangers as specified with a capped pipe cross member.

Where clearance between pipe and overhead support is insufficient for the use of other hangers specified, use Michigan Model No. 605 or equal.

Horizontal steel or cast iron piping shall be supported as follows:

Pipe Size	Rod Diameter	Maximum Spacing
Up to 1-1/4 inch	3/8 inch	8 feet
1-1/2 inch & 2 inch	3/8 inch	10 feet
2-1/2 inch & 3-1/2 inch	1/2 inch	15 feet
4 inch & 5 inch	5/8 inch	15 feet
6 inch	3/4 inch	17 feet
8 inch through 12 inch	7/8 inch	22 feet

Horizontal copper piping shall be supported as follows:

Pipe Size	Rod Diameter	Maximum Spacing
Up to 1 inch	3/8 inch	6 feet
1-1/4 inch & 1-1/2 inch	3/8 inch	8 feet
2 inch	3/8 inch	9 feet
2-1/2 inch	1/2 inch	9 feet
3 inch & 4 inch	1/2 inch	10 feet

For vertical piping, where supports are not indicated on the Drawings, support steel and copper pipe at every other floor, support cast iron soil pipe at every floor and PVC piping at every floor and at 5 feet intervals between floors.

Pipe hangers shall not be attached to the roof deck. Hangers shall be attached to the structure with beam clamps, beam attachment and brackets bolted to joists and beams. Use Michigan Model No. 340 or equal, steel washer plates for pipe supported from steel joist. The Contractor shall endeavor to hang near joist panel joints wherever possible.

Pipe hangers for cold piping, horizontal downspout piping and all insulated piping on trapeze hangers shall be large enough to encompass the insulation, using a metal shield so the vapor barrier jacket will not be broken. See Insulation Section.

Pipe mounting brackets for cold piping shall be large enough to encompass the insulation B-Line Model B2417 or equal. This piping shall be anchored securely at the point of connection to plumbing fixtures. The last mounting bracket adjacent to fixtures and equipment may clamp directly onto the pipe. A short length (18 inches maximum) of piping between the last bracket and the connection is allowed without insulation.

Hanging from one pipe to another is prohibited.

Pipe Hangers shall be Michigan, Grinnell, PHD, B-Line or equal.

1.32 PIPING INSTALLATION:

All pipes shall be round and straight, of required size. Cutting shall be done with proper tools and pipes shall be reamed to full size after cutting.

Piping shall be properly enclosed, supported, guided, anchored, sway braced, connected, tested, cleaned and flushed out and shall be properly insulated and protected where required.

All pipes shall be run with proper grade to provide for easy draining and in group runs where applicable and in a neat and orderly manner, to the satisfaction of the Architect/Engineer. Lines required to be enclosed in ceiling, chaseways or similar spaces shall be installed to permit such enclosure as intended. All pipe runs shall be carefully laid out and scheduled to avoid necessary interferences with other work. Pipe sizes shown on the Drawings are nominal pipe sizes and not outside diameters.

Pipes shall be run substantially as indicated on the Drawings. However, the Architect/Engineer reserves the right to require this Contractor to make changes in pipe locations where conflicts occur with other trades. Such changes shall be made without extra cost to the Owner.

Piping shall be installed with ample provisions for expansion and contraction to prevent injury to the same and to the building construction. Such provision shall be made by means of piping offsets, changes in direction, expansion loops and/or suitable expansion joints. Suitable anchors and guides shall be provided to permit proper deflection and compression of offset loops and expansion joints. Expansion joints shall not be used in lieu of offsets, changes in direction or loops, except where specified and/or indicated on the Drawings or where otherwise obviously necessary.

Exposed piping shall be installed in a sanitary manner for ease in cleaning. Pipe shall be cut and threaded to fit the installation. Wherever possible, rough-in exposed pipe connections at the wall rather than the floor for ease in cleaning.

Equipment piping shall also include wastes and drains which are safe-wasted without a direct connection.

Minimum grade for horizontal drainage piping shall be 1/4 inch per foot for 3 inch diameter piping or less, 1/8 inch per foot for 4 inch and 6 inch diameter piping and 1/16 inch per foot for drainage piping over 6 inch diameter.

1.33 WELDED PIPING SYSTEMS:

The following specification covers permissible assemblies for welded pipe lines for all services operating at 160 psig or less.

All welding shall be performed by certified welding operators and in accordance with procedures recommended in the latest revision of the Code for Pressure Piping ASA B31.1. No welding may be done prior to a welding certificate being submitted and accepted for the person or persons designated to do all the welding.

The use of mitered elbows in welded lines will not be permitted. Welding elbows shall be used for all bends.

Mitered tees will not be permitted in welded lines. Connections shall be made with welding tees. The use of weldolets will be permitted in lieu of welding tees in welded lines provided they are installed in prefabricated assemblies and the pipe interior is cleaned of slag. Field installation of weldolets will be permitted where the branch piping is one-half the size of the main piping or less.

Mitered reducers will not be permitted in welded lines. Reduction in lines shall be made with welding reducers.

Pipe caps in welded lines may be fabricated from flat steel plate cut round and inserted into the pipe a sufficient depth to permit a fillet weld equal to the plate thickness. The plate thickness shall be twice the pipe wall thickness for pipe sizes 12 inches or less.

The pipe ends in all tees, laterals and reducers shall be carefully prepared to provide for proper weld penetrations in accordance with ASA Standards. Long radius, reducing type, butt welding elbows, in size 2-1/2 inch and larger, shall be used at pump and equipment connections wherever a change in pipe size and a 90 degree change in direction are involved.

Butt welding tees, forged steel socket welding tees or forged steel welding outlet fittings shall be used for making branch connections in welding piping systems.

Pipe ends and other pipe joints which are to be welded shall be carefully prepared to provide for proper weld penetration.

1.34 PRESSURE GAUGES:

Furnish and install U.S. Gauge Model 5105 or equal pressure gauges in pipelines and on equipment as indicated herein and/or where shown on the Drawings. Gauges shall have phosphor bronze bourdon tube with brass movement.

Gauges shall be compound, pressure or vacuum as required with 4-1/2 inch diameter dial. Each gauge shall be complete with Trerice No. 872 pressure snubbers, and brass ball valves. Ball valves shall be provided on all gauges at the inlet and outlet of each and all heating and cooling circulating pumps, and chillers.

The normal operating pressure of each gauge shall be 50-70 percent of full scale. The range of the scale shall be suitable for the application.

The gauges shall be located and mounted such that they can be conveniently read by a person standing on the equipment room floor. Accuracy shall be Grade "A". Case shall be aluminum.

Pressure gauges shall be U.S. Gauge, Trerice, Weksler, Ashcroft, Weiss or equal.

1.35 THERMOMETERS:

Furnish and install Weiss "Thriftline" TL5S2 or TS5A2 or equal thermometers in pipelines and equipment as tabulated and/or where shown on the Drawings. Thermometers shall have a minimum of 6 inch scale with separable socket, cast aluminum case, red reading mercury, industrial type complete with thermometer wells.

The normal operating temperature of each thermometer shall be at 50-70 percent of full scale. The range of the scale shall be suitable for the application.

Thermometer installation will not be accepted unless they can be easily read by an operator standing on the floor.

Thermometers shall be provided at the inlet and outlet of each and all chillers, boilers, heat exchangers and storage tanks supply and return piping. Thermometers shall also be required on the outlet of all domestic water heaters and mixing valves.

Thermometers shall be Weiss, Trerice, Weksler or equal.

1.36 PRESSURE/TEMPERATURE TEST PORTS:

Furnish and install where indicated on the Drawings or tabulated below pressure/temperature test ports. Port shall be solid brass with valve cores capable of receiving either temperature or pressure probe with 1/8 inch o.d. Cores shall be Neoprene when application maximum temperature is 200 degrees F. or less and 500 psi, or Nordel for temperature up to a maximum of 275 degrees F. at 500 psi.

Pressure/temperature test ports shall be installed at each and all heat/cooling coil inlets and outlets. On coils with 3-way control valves an additional port shall be required between the control valve discharge and the balance valve or flow meter.

Provide test ports at the inlet and outlet of each and all pumps, hot water generators, cold water generators, coils, heat exchangers and storage tanks supply and return piping unless permanently mounted pressure and temperature measuring devices are indicated elsewhere in the specifications or shown on the Drawings.

Test Plugs shall be Sisco, Pete's or equal.

END OF SECTION 220100

SECTION 220400 – PLUMBING

1.01 SCOPE:

The GENERAL, SUPPLEMENTAL and other CONDITIONS of the Contract and the GENERAL REQUIREMENTS (Division 1) are hereby made part of this Section.

Section 220100, General Provisions, in its entirety, including references to the General Construction Specifications, are hereby adopted and made part of these Specifications.

The work involved in this specification and the accompanying Drawings consists of performing all labor and furnishing of all materials, fixtures and equipment necessary to install complete sanitary sewer systems and potable hot and cold water systems, as described herein and/or shown on the Drawings. This includes all piping, wiring and materials obviously necessary for complete systems though not specifically mentioned or shown.

See Section 220850 for insulation requirements.

1.02 SYSTEM OF PLUMBING:

The continuous waste and vent method of plumbing shall be installed. Hot, tempered and cold water lines are to be installed where shown. All water piping in finished areas shall be concealed in joist spaces above ceilings, and in walls.

Pipes run overhead shall be placed as close to the ceiling as possible, to maintain proper headroom and to present a neat appearance, all consistent with the pitching of pipes for drainage of the systems.

The plumbing work shall be installed in strict accordance with the best plumbing practice, all subject to the Architect/Engineer's approval in accordance with all applicable local, state and national plumbing regulations.

1.03 PLUMBING VENT THRU ROOF (VTR):

Vent stacks from sewer, soil, waste and drain pipes shall be extended at least 12 inches above the roof. The top of the vent shall be designed so as to permit the insertion therein of a testing plug of such form that it can be readily seen until removed, and said plug shall be removed at once after final inspection has been made and approved by the Architect/Engineer. The minimum size of any vent passing through roof shall be 4 inches.

1.04 ROOF JACKETS:

Vent stacks from sewer, soil, waste and drain pipes shall be extended at least 12 inches above the roof, and shall be encased in frostproof jackets, Moore No. 1 or equal. Each shall have an air space of at least 1 inch between the outside surface of the pipe and the inside surface of the frost jacket. The top of the frost jacket shall be designed so as to permit the insertion therein of a testing plug of such form that it can be
readily seen until removed, and said plug shall be removed at once after final inspection has been made and approved by the Architect/Engineer. The minimum size of any vent passing through roof shall be 4 inches.

The frostproof jackets shall be galvanized steel for all galvanized steel, cast iron, and ABS or PVC plastic vent piping. The frostproof jackets shall be copper for all DWV copper vent piping.

1.05 CLEANOUTS:

Full size brass screw cleanout plugs shall be furnished and installed at the bottom of all soil and waste stacks and at all points where shown on the Drawings and where necessary to permit the entire drainage system to be rodded out easily. Floor drains located in branch lines shall have cleanouts adjacent to the drains.

Floor cleanouts shall be cast iron with inside caulk ferrule, brass plug, adjustable housing and round nickel brass secured frame and scoriated cover. Wade covers shall be heavy duty. In ceramic and quarry tile floor finishes the cover shall be square. The cover shall be provided to accept the floor covering in the location being installed, i.e., synthetic covering, composition tile, terrazzo, etc., Zurn Z-1425, Wade W-6010; Josam 58100; or equal. Flashing clamp and collar shall be furnished with all cleanouts installed in floors having waterproof membranes. Wall and ceiling plates shall be Zurn Z-1460-9, Wade W-8480-R, Josam 58600, or equal.

Cleanouts shall be Wade, Zurn, Josam, Ancon, J. R. Smith, Mifab, Sioux Chief or equal.

1.06 FLOOR DRAINS:

Furnish and install floor drains where shown on the Drawings and as specified or equal. All floor drains installed in floors with waterproof membranes shall have flashing clamps.

Floor drains except in mechanical rooms, garages and the like shall be Josam Series 30000-A, Wade W-1100 or equal with 5 inch diameter Nickaloy strainer having a minimum of 7.3 square inch free area. In ceramic and quarry tile floor finishes the floor drain strainer shall be square. Furnish and install a deep seal trap.

Floor drains in mechanical rooms shall be Josam Series 30000-E, Wade W-1100-TS or equal with heavy duty 8 inch diameter grate. Furnish and install a deep seal trap with cleanout.

Floor drains shall be Josam, Zurn, Wade, Smith, Ancon, Mifab, Sioux Chief or equal.

1.07 ROOF DRAINS AND DOWNSPOUT NOZZLES:

Furnish and install Wade W-3000, Josam Series 21500 cast iron roof drains or equal where shown on the Drawings. The roof drains shall be complete with flange, flashing ring with integral gravel stop, non-corrosive clamping units, locking type metal dome strainers, and extensions as required by insulation thickness.

Overflow roof drains shall be Wade W-3000-SD Josam 26010 cast iron roof drains or equal where shown on the Drawings. The drains shall be complete with flange, flashing ring with integral gravel stop, non-corrosive damping units, locking type dome strainers, and extensions to match the roof insulation thickness. The standpipe height shall be 2 inches above the adjacent roof drain or roof line, whichever is of higher elevation.

Furnish and install Wade W-3940, Josam Series 25010 cast brass downspout nozzles or equal with threaded outlet and flange at each downspout discharge as shown on the Drawings. Unless noted otherwise, the downspout nozzle shall be located 18 inches above grade. The nozzle flange shall be anchored to the wall with brass screws.

Roof drains and downspout nozzles shall be Wade, Josam, Zurn, G-O-N, Smith, Ancon, Mifab, Sioux Chief or equal.

1.08 WASTE, VENT AND WATER CONNECTIONS TO FIXTURES:

Rough-in for waste, vent and water connections at the various fixtures shall be as follows, unless noted otherwise:

	Waste	Vent	Water
Water closet (tank)	4"	2"	1/2"
Water closet (flush)	4"	2"	1-1/4"
Urinal	2"	1-1/2"	1"
Lavatory	1-1/2"	1-1/2"	1/2"
Sink	2"	1-1/2"	1/2"
Kitchen sink	2"	1-1/2"	1/2"
Service sink and receptor	3"	1-1/2"	1/2"
Drinking fountain and EWC	1-1/4"	1-1/4"	1/2"

Waste, vent and water supply piping to plumbing fixtures and equipment which is not shown on the Drawings shall be provided and shall be amply sized in accordance with the above schedule. All plumbing fixtures, wastes, and drains shall be vented in accordance with all applicable Local, State and National Plumbing Regulations.

1.09 PLUMBING FIXTURES:

Furnish and install all plumbing fixtures as specified hereinafter and as designated on the Drawings. Catalog numbers shown are used to designate the type of fixture desired. Special equipment included in this schedule is identified by brand name and number.

Caulk around all floor and wall mounted fixtures. Caulking shall be done in a skilled manner with silicone based white acrylic latex caulk. Caulking shall be water tight, flexible, mildew and shrink resistant.

All exposed flush, waste and supply pipes at the fixtures shall be chromium-plated brass pipe, iron pipe size. No steel nipples or cover tubes will be allowed. The stop valves, pop-up wastes,

flush valves, etc., shall be heavy cast brass chromium-plated. Waterlines to all the individual fixtures, where exposed, shall be equipped with high grade, loose key chromium plated brass stop valves unless scheduled otherwise on the Drawings. All chromium plating shall be applied over a nickel plated base. Enameled fixtures shall be acid resistant. Provide backing in the wall to support the fixture. All water closets shall have bolt caps with retainer clips. Groups of fixtures shall be matched.

The Schedule shown on the Drawings is given for the convenience of the Contractor who is to be responsible for exact quantities. Any fixtures indicated on the Drawings, but not specifically mentioned in the Specifications or scheduled, shall be furnished by the Contractor.

Plumbing Fixtures shall be as scheduled, American Standard, Crane, Eljer, Briggs, Kohler, Sloan, Vitra, Zurn-One, or equal.

Fixture carriers shall be Josam, Wade, Zurn, Blake, Smith, Watts or equal.

Brassware shall be the manufacturer's own brass, Chicago Faucet, T&S Brass, Speakman, Cambridge Brass, Zurn as scheduled or equal. Faucets shall meet NSF Standard 61, Section 9 for drinking water.

Lavatory faucets shall have a lifetime warranty against leaking and shall be equipped with temperature limit stops and vandal resistant aerators. Faucet bodies shall be chrome-plated zinc die-cast or solid cast brass (polished or chrome plated) as scheduled on the Drawings. Lavatory faucets shall be American Standard, Eljer, Delta, Moen, Zurn, Chicago/Geberit, Kohler, Sloan, Bradley, Speakman, T&S Brass, Cambridge Brass or equal.

Fiberglass shower enclosures shall be Warm Rain, Aqua Glass, Lasco, Kohler, Aquarius or equal.

Mop sinks shall be Fiat, Stern Williams, Swan, Mustee, Zurn as scheduled or equal.

Stainless Steel sinks shall be Elkay, Carlton, Just, as scheduled or equal.

Water Closet seats shall be as scheduled, Centoco, Church, Bemis, Beneke, Sperzel, Olsonite, or equal.

Flush Valves shall be as scheduled, Sloan , Zurn or equal.

1.10 MIXING VALVE:

Furnish and install a Lawler Model 803 or equal thermostatic mixing valve where shown on the Drawings.

The valve shall have a range from 90 degrees F. to 120 degrees F.

Temperature adjustment control shall be tamper-resistant.

Water mixing valve shall be of the thermostatic type with liquid filled thermal motor. It shall have bronze body construction with replaceable corrosion resistant components. Valve construction shall employ a sliding piston control mechanism. Sliding piston and liner shall be of stainless steel material. Valve shall come equipped with union end stop and check inlets with

removable stainless steel strainers. Valve shall provide protection against hot or cold supply line failure and thermostat failure.

Valve capacity range shall be 2 gpm to 65 gpm at a maximum pressure differential of 30 psi. The valve shall control within +/- 3 of the setpoint throughout the adjustment range.

Valves shall be MCC Powers, Lawler, Symmons, T & S Brass, Leonard or equal.

1.11 CIRCULATING PUMPS:

Furnish and install Bell and Gossett Model PL or equal in-line circulating pumps on the hot water circulating piping where shown on the Drawings.

Pumps shall be horizontal, permanently lubricated type, specifically designed and guaranteed for quiet operation and suitable for 150 psi working pressure.

The pumps shall have a steel shaft supported by permanently lubricated, sealed precision ball bearings. The pumps are to be equipped with a water-tight seal to prevent leakage. Mechanical seal faces shall be carbon on silicon carbide. The motor shall be non-overloading at any point on the pump performance curve.

The pump shall be of all bronze construction suitable for domestic water use.

The motor shall be of the drip-proof, sealed precision ball-bearing, quiet-operating construction. The permanent split-capacitor motor shall be equipped with thermal overload protection.

Pumps to be suitable for 225 degrees F (107 degrees C) operating temperature at 150 psig (10 bar) working pressure.

The pump shall be directly driven, 115 volt, 60 cycle, 1 phase motor.

Capacities shall be as scheduled on the Drawings.

Circulating Pumps shall be Bell & Gossett, Taco, Armstrong, Amtrol or equal.

1.12 GREASE INTERCEPTOR:

Furnish and install a Schier Products Model PATG-EXT-SC-2420 or equal grease interceptor where shown on the Drawings.

The interceptor shall be a high density polyethylene separator for flush with floor installation with 30 GPM, 90 pound sludge capacities, 4 inch no hub inlet and outlet connections, visible double-wall outside trap seal, easily removable separator screen and heavy duty non-skid gasketed cover suitable for pedestrian traffic secured with stainless steel bolts.

Separator shall include a 1/4 inch steel treadplate cover and extension to match finished floor elevation.

Cast iron interceptors with equal capacity and flow rate are acceptable.

Grease Interceptor shall be Schier, Josam, Zurn, Smith, Ancon or equal.

1.13 SHOCK ABSORBERS:

Piping shall be installed with proper safeguards to prevent water hammer. This will be done by installing a sufficient number of shock absorbers where indicated on the Drawings. Air cushion shall be same size as piping on which installed, 16 inches long, with removable cap wherever accessible.

The commercial shock absorbers indicated on the Drawings shall be sized as follows:

Size	Fixture Units
SA-1	1 -11
SA-2	12-32
SA-3	33-60
SA-4	61-113
SA-5	114-154
SA-6	155-330

Shock Absorbers shall be Josam, Wade, Zurn, Sioux Chief or equal.

1.14 WALL HYDRANTS:

Furnish and install 3/4 inch freezeless type wall hydrants where shown on the Drawings. Wall hydrants shall be Woodford Model 65-C or equal, modular brass body with brushed chrome finish and self-draining vacuum breaker. Operating stem shall be hardened stainless steel with loose-key operator. Provide a key with each hydrant and unless stated otherwise, the hydrant shall be installed 24 inches above finished grade.

Wall hydrants shall be Woodford, Zurn, Smith, Watts or equal.

1.15 HOSE BIBBS:

Furnish and install Chicago No. 952 or equal, hose bibbs where shown on the Drawings. Hose bibbs shall have flanged female type 3/4 inch thread inlet, 3/4 inch hose thread outlet, vacuum breaker, and polish chrome plate finish. Unless noted otherwise, the hose bibb shall be installed 42 inches above finished floor.

Hose Bibbs shall be Nibco, Watts, Woodford, Zurn or equal.

1.16 WATER SERVICE AND METER:

Furnish and install a water meter where shown on the Drawings. The water meter shall be purchased from the City or shall be of the type approved by the City. All costs for service fees, water meter etc., shall be the responsibility of this Contractor. All work shall be in accordance with all applicable Local, State, and National plumbing regulations.

1.17 SANITARY SEWER SERVICE:

Furnish and install sanitary sewer service as shown on the Drawings. The service within 5'-0" of the building and as designated on the Drawings shall be cast iron or PVC pipe and fittings. The service shall be extended into the existing sanitary sewer manhole at a uniform grade. The Contractor shall verify all invert elevations before beginning excavations.

The complete installation shall be in accordance with all applicable, Local, State, and National plumbing regulations.

1.18 STORM SEWER SERVICE:

Furnish and install storm sewer service as shown on the Drawings. The service within 5'-0" of the building and as designated on the Drawings shall be cast iron or PVC pipe and fittings. The service shall be extended to the existing storm sewer. The service shall be installed at a uniform grade and the Contractor shall verify all invert elevations before beginning excavation.

1.19 GAS SERVICE:

Outside gas service to the meter location shown on the Drawings along with the gas meter and pressure regulator, will be installed by the Local Gas Company. Any costs for installation and/or relocation of outside gas service, shall be paid by the Contractor, and this cost shall be included in the Contractor's Base Bid.

1.20 DOUBLE CHECK BACKFLOW PREVENTER:

Furnish and install Watts Regulator Co., series No. 007-S, 709-S or equal double check backflow preventers where shown. The backflow preventer shall be a complete assembly including tight closing shut-off valves before and after the device and also be protected by a strainer. It shall be a complete assembly including four ball type test cocks.

The device shall meet the requirements of A.S.S.E. standard 1015 and A.W.W.A. standard C506.

Double Check Backflow Preventer shall be Watts, Hersey, Conbraco, Febco, Wilkins or equal.

1.21 ELECTRIC WATER COOLERS:

Furnish and install electric water coolers where shown on the Drawings. Units shall have a light touch push bar, bubbler, pressure regulator, hermetic compressor, stainless steel top and receptor, stainless steel cabinet. Units shall be air cooled with fractional horsepower, 115 volt, single phase motor including integral thermal overload protection and 3-wire grounded plug. The front panel shall extend down to cover the electrical plug and cord. Entire unit shall be guaranteed for 5 years.

Handicapped units shall be mounted with the outlet orifice at 36" maximum and standard units shall be mounted with the outlet orifice at 42" above finished floor unless noted otherwise on the Drawings.

Water cooler capacity shall be 7.6 gph of 50 degrees F. water with an 80 degrees F. inlet water temperature and 90 degrees F. ambient room temperature.

Water coolers shall be Elkay, Oasis, Halsey-Taylor, Sunroc, General Electric, Haws or equal.

1.22 ELECTRIC WATER COOLERS (TWO LEVEL):

Furnish and install a two level electric water coolers where shown on the Drawings. Units shall have light touch push bars, bubblers, pressure regulator, hermetic compressor, stainless steel tops and receptors, stainless steel cabinet faceplate. Units shall be air cooled with fractional horsepower, 115 volt, single phase motor including integral thermal overload protection and 3-wire grounded plug. Entire unit shall be guaranteed for 5 years.

The electric water cooler shall be ADA compliant and shall be lead free.

Furnish the cooler with an apron under the upper unit when the cooler is not installed in a recessed area.

Handicapped units shall be mounted with the outlet orifice at 36" maximum and standard units shall be mounted with the outlet orifice at 42" above finished floor unless noted otherwise on the Drawings.

Water cooler capacity shall be 7.6 gph of 50 degrees F. water with an 80 degrees F. inlet water temperature and 90 degrees F. ambient room temperature.

Water Coolers shall be Elkay, Oasis, Halsey-Taylor, Sunroc, General Electric, Haws or equal.

1.23 TESTS:

The following tests shall be performed on the respective systems. Tests shall be repeated until each system is proven acceptable.

The Contractor is responsible for the following tests:

Soil, waste, and vent piping and rain water conductors, etc., shall be tested in accordance with applicable state and local codes. Unless stated otherwise in the applicable codes, these systems shall be tested with 5 psi air pressure for a period of 15 minutes with a maximum drop of 1 psi during this period.

Cold, hot and recirculating hot water shall be tested and proven watertight under a hydrostatic pressure of 100 psi.

END OF SECTION 220400

SECTION 220600 - HEATING

1.01 SCOPE:

The GENERAL, SUPPLEMENTAL and other CONDITIONS of the Contract and the GENERAL REQUIREMENTS (Division 1) are hereby made part of this Section.

Section 220100, General Provisions, in its entirety, including references to the General Construction Specifications, are hereby adopted and made a part of these specifications.

The work involved in this specification and the accompanying drawings consists of performing all labor and furnishing of all materials, fixtures and equipment necessary to install complete heating system as described herein, and/or as shown on the Drawings. This includes all piping, equipment, wiring and materials obviously necessary for complete systems though not specifically mentioned or shown.

See Section 220850 for insulation requirements.

1.02 CABINET UNIT HEATERS (CUH):

Furnish and install Cabinet Unit Heaters where shown on the Drawings. Types, sizes and performance shall be as tabulated in the schedule on the Drawings.

Floor type cabinets shall be a vertical console type enclosure fabricated of galvanized steel, phosphatized and finished in a baked enamel with the color to be selected by the Architect/Engineer from a standard color chart. Cabinet shall include integral bar (front) discharge grille and full width electrical and piping compartments with access doors at each end.

Basic unit shall consist of base casing with wall plate fabricated of galvanized steel, top duct discharge opening or for installation in custom enclosure.

Horizontal cabinet models shall consist of 18 gauge steel panels. Bottom and end panels shall have channel formed edges around the entire panel perimeter. Integral, stamped outlet and inlet grilles, where required, shall have 15 degrees downward deflection. Bottom panel shall be hinged at the front and camlocked at the back.

Horizontal recessed models shall consist of 18 gauge steel removable, four-sided overlapped bottom panel with piano-type hinge at the back and camlocks at the front. The fan shall be enclosed with a filter rack at the inlet.

Coils shall have aluminum fins with copper tubes mechanically expanded for a permanent bond. Coils shall have a factory installed manual air vent. Coil performance shall be as tabulated in the schedule on the Drawings.

Fans shall be DWDI forwardly curved, centrifugal type. Fan housing shall be fabricated of heavy gauge galvanized steel and of 2-piece construction with removable front half for complete access to fans.

Units shall have 115/60/1 single speed, sleeve bearing, permanent split capacitor motors with oilers, inherent thermal overload protection with automatic reset, disconnect switch and resilient mounts.

Units shall have a unit mounted solid state variable speed controller with integral "on-off" switch which shall provide "high","medium","low" fan speed control. All capacities are based on high fan speed.

Cabinet Unit Heaters shall be Trane, McQuay, Airtherm, Carrier, Beacon Morris, International, Dunham-Bush, Sterling, York, Modine, Rittling, Sigma or equal.

1.03 PROPELLER UNIT HEATERS:

Furnish and install Propeller Unit Heaters where shown on the Drawings. Unit sizes, types, performance and equipment shall be as tabulated in the schedule on the Drawings.

Cabinet shall be manufactured from die formed heavy gauge continuous galvanized steel. Cabinets shall be finished with a baked-on enamel to provide durable protection. Horizontal unit heaters shall have adjustable louvers for adjustable air flow.

Units shall have 115/60/1 single speed, sleeve bearing, permanent split capacitor motors with oilers, inherent thermal overload protection with automatic reset and resilient mounts. Units shall have a unit mounted “on-off” switch.

Manufacturer shall provide all units with fan guards which meet OSHA requirements.

Units shall be furnished with high efficiency coils. Standard coils shall be rated up to 150 PSIG and up to 366 degrees F in temperature. High pressure coils shall be rated for up to 350 PSIG and 450 degrees F in temperature. All units with steam pressure above 25 PSIG shall have high pressure coils.

Down flow units shall be provided with (single) deflectors where indicated on the schedule. Horizontal air flow units shall have (single deflection) louvers.

Propeller Unit Heaters shall be Trane, McQuay, Airtherm, Carrier, Beacon Morris, Dunham-Bush, Sterling, Modine, Rittling, Sigma or equal.

1.04 HOT WATER RADIANT CEILING PANELS:

Furnish and install Hot Water Radiant Ceiling Panels where shown on the Drawings. All radiant panels shall be installed by personnel wearing white gloves to avoid soiling the panels. The ceiling supplier shall instruct the Contractor's personnel as to proper installation procedures.

Contractor shall refer to Room Finish Schedule and Architectural and Mechanical Drawings for locations of surfaces to be covered with various types of radiant metal pan units. Also refer to the architectural details which apply to this installation.

The radiant-acoustical panels shall produce a minimum heating output of 225 BTU per hour per square foot at 190 degrees F. mean water temperature (M.W.T.) in a room with 70 degrees F. air temperature, 67 degrees F. average unheated surface temperature, natural air convection, and one inch of three quarter pound density fiberglass insulation placed on the top side of the panel.

Radiant heating panels shall be perforated or non-perforated panels, consisting of 0.040" aluminum face plate, 6 pass 1/2" copper serpentine coil metallurgically bonded to face plate, 1" thick 3/4 lb. density glass fiber pads, and shall be of sizes as shown on Drawings.

All metal ceiling panels shall have two coats, baked white polyester finish, with a light reflection value of 70% to 80%.

It is the responsibility of this Contractor to coordinate his work with the reflected ceiling plans. Provide recess mount; Airtex Model ARF, or equal; trim kits wherever panels are mounted in plaster or gyp board ceilings. Frames shall be single piece, aluminum exterior frames with welded corners.

No installation of finished ceiling surface panels or sound absorbing elements shall begin until all glazing has been completed and all exterior openings closed in. All wet work, including cement, plastering, terrazzo, etc., shall be completed and dried out before finished ceiling panels are installed. Any or all trades responsible for the damage of ceiling panels due to unauthorized removal, and other neglects, shall be held responsible for the replacement of such parts.

Hot Water Radiant Ceiling Panels shall be Airtex, Shelley, AeroTech, Barcol Air or equal.

1.05 DUCT MOUNTED HEATING COILS:

The duct mounted heating coils are specified under Section 15800. The duct mounted heating coils shall be furnished and installed under Section 15800. This specification shall include the furnishing and installing of all valves, unions, air vents, etc., and make connections to the duct coils. Automatic control valves shall be furnished by the Automatic Temperature Control Contractor and installed under this specification.

1.06 STRAINERS:

Furnish and install, where shown on the Drawings, and where required, a "Y" type strainer.

Strainers shall have steel or brass bodies, with 20 mesh stainless steel screens. The pressure drop shall not exceed 0.1 PSI at rated flow. All strainers shall be rated at 125 psig steam working pressure minimum and 200 psig water working pressure minimum. All strainers shall be provided with a blowdown valve.

Strainers shall be Hoffman, Dunham-Bush, Sarco, Clark-Reliance, Armstrong, Illinois, Titan or equal.

1.07 AIR VENTS:

On each heating and cooling element, at the top of each heating or cooling pipe riser, and wherever required to vent the system, furnish and install a Taco No. 400, Bell & Gossett No. 4V or equal air vent.

At all points shown, furnish and install automatic air vents which shall be Sarco 13W, or Thrush/Amtrol Model 720.

1.08 HEATING AND COOLING ELEMENT VALVING:

Hot Water Radiation, Convectors and Unit Heaters: Install shutoff valves on the supply side of the coil and balancing valves on the return side. Where temperature control valves are used, the manual valves shall be installed to isolate both the temperature control valve and the coil.

Chilled Water Coils: Provide shutoff valves on the supply to the coils and a balance valve on the return from the coils. Multiple section coil banks shall have the respective supply and return valves on each section.

Hot Water Coils: Provide shutoff valves on the supply to the coils and a balance valve on the return from the coils. Multiple section coil banks shall have the respective supply and return valves on each section.

See Drawings for additional valving requirements.

1.09 BASE MOUNTED CIRCULATING PUMPS:

Furnish and install base mounted circulating pumps with capacities as shown on the Drawings. Pumps shall be base mounted, single stage, end suction design with a foot mounted volute to allow servicing of the impeller and bearing assembly without disturbing piping connections.

Pump volute shall be Class 30 cast iron with integrally-cast pedestal support feet. The impeller shall be cast bronze enclosed type, dynamically balanced, keyed to the shaft and secured by a locking capscrew.

The liquid cavity shall be sealed off at the pump shaft by an internally-flushed mechanical seal with ceramic seal seat and carbon seal ring, suitable for continuous operation at 225^{o}F. A replaceable bronze shaft sleeve shall completely cover the wetted area under the seal.

Pump shall be rated for minimum of 175 psi working pressure. Volute shall have gauge tappings at the suction and discharge nozzles and vent and drain tappings at the top and bottom.

Base plate shall be of structural steel or fabricated steel channel with fully enclosed sides and ends, and securely welded cross members. Grouting area shall be fully opened. A flexible type, center drop-out design coupler, capable of absorbing torsional vibration, shall be employed between the pump and motor. Coupler shall be shielded by a coupler guard securely fastened to the base.

High efficiency motors shall meet NEMA specifications and shall be of the size and voltage scheduled on the Drawings. Pump and motor shall be factory aligned, and shall be realigned by contractor after installation.

Each pump shall be factory tested per Hydraulic Institute standards. It shall then be thoroughly cleaned and painted with at least one coat of high grade machinery enamel prior to shipment.

Base Mounted Circulating Pumps shall be Bell & Gossett, Taco, Armstrong, Amtrol, Patterson or equal.

1.10 IN-LINE CIRCULATING PUMPS:

Furnish and install "in-line" centrifugal circulating pumps similar to Bell & Gossett Series 60, 80 or equal.

Pumps shall be complete with cast iron volutes, bronze impellers, carbon steel shafts, and mechanical seals. Bronze sleeve pump bearings shall be oil lubricating. Pump and motor shall be close-coupled with a flexible spring type coupler for quiet operation.

Pump capacities shall be as listed in the schedule on the Drawings.

Circulating pumps shall be Bell & Gossett, Taco, Armstrong, Amtrol, Patterson or equal.

1.11 SUCTION DIFFUSERS:

Provide at each end suction pump a suction diffuser at the inlet to the pump. Units shall consist of angle type body with straightening vanes and combination diffuser-strainer-orifice cylinder with 3/16" diameter openings for pump protection. A permanent magnet shall be located within the flow stream and shall be removable for cleaning. The orifice cylinder shall be equipped with a disposable fine mesh strainer which shall be removed after system start-up. Orifice cylinder shall be designed to withstand pressure differential equal to pump shutoff head and shall have a free area equal to five times cross section area of pump suction opening. Straightening vanes shall extend the full length of the orifice cylinder and shall be replaceable. Unit shall be provided with adjustable support foot to carry weight of suction piping.

Suction Diffuser shall be Bell & Gossett, Mueller Steam Specialty, Victaulic, Taco, Shurjoint, Armstrong or equal.

1.12 EXPANSION TANK(S):

Furnish and install Bell & Gossett expansion tank(s) of ASME construction for 125 psig working pressure or equal and sized as shown on the Drawings. Provide gauge glass(es) and tappings on bottom of the tank for installation of tank fitting and drain. Tappings shall be manufacturer's standard size.

Tank(s) shall be hung from overhead structure with four 1/2 inch rods and 3" x 3" x 1/4" angle at each end. If tanks are installed adjacent to each other, hanger rods shall be installed between each pair of tanks.

Tank(s) shall be Bell & Gossett, John Wood, Ace, Armstrong, Amtrol, Adamson, Taco, Wessels or equal.

1.13 AIR SEPARATORS:

Furnish and install Bell & Gossett Model RL Rolairtrol air separator(s) or equal, where shown on the Drawings. Unit shall be constructed in accordance with ASME Code and stamped for 125 psig working pressure. Air separators shall have 90 percent minimum efficiency and head loss shall not exceed 3.0 feet at rated flow.

Air separator for the heating system shall be Model RL-4 having a capacity of 280 gpm minimum.

Air separator for the cooling system shall be Model RL-6 having a capacity of 800 gpm minimum.

Air Separators shall be Bell & Gossett, Taco, Armstrong, Amtrol or equal.

1.14 HIGH EFFICIENCY BOILER:

The heating boiler shall be a CAMUS DYNAFORCE model DR having an input rating as shown on the Drawings.

The hydronic heating boiler shall be design certified by CSA International and shall meet the requirements of ANSI Z21.13, and CSA 4.9. The heating boiler shall be vented as a Category II or IV condensing appliance.

Performance Overview:

1. Boiler shall operate up to 99% thermal efficiency
2. Heat exchanger shall be a fully condensing primary-secondary cylindrical counter-flow water tube design with 439 grade stainless steel construction and all welded design with constant allowable system return temperatures of 40F.
3. Fine tuned combustion premix providing homogeneous air and gas combustion mix to a radial burner incorporating a knitted stainless steel wrap ensuring stable light off and efficient clean combustion.
4. 5:1 gas input turn down ratio with sustained efficient combustion characteristics throughout entire modulating range
5. Oxides of Nitrogen (NOx) of 9 ppm corrected to 3% oxygen.
6. Category II venting certification with Category II and IV venting options.
7. The boiler is fully factory fire tested to obtain optimum combustion characteristics and to establish certified gas input rates.
8. System safety and operating devices and controls are fully configured, calibrated and factory tested.
9. The boiler shall comply with the energy efficiency requirements of the latest edition of the ASHRAE 90.1 Standard.

The combustion chamber shall be an all welded stainless steel construction and an integral part of the heat exchanger which shall be an all welded vertical cylindrical stainless steel counter-flow design consisting of an upper burner section for primary heat transfer and a lower section for extracting latent heat from flue gases. Stainless steel access heat exchanger wraps shall be provided for ease of service and inspection of the external heat exchanger and an easily removable radial fired knitted fiber stainless steel burner to access the internal combustion chamber for inspection, service, and cleaning. A window view port shall be provided for visual inspection of the boiler combustion during firing.

The stainless steel heat exchanger shall be inspected and tested to A.S.M.E. Section IV requirements. The A.S.M.E. Section IV seal of approval will not be provided as standard for jurisdictions not requiring the A.S.M.E Section IV seal of approval. The stainless steel heat exchanger shall be a 12 pass primary secondary design with a maximum working pressure of 160

psig (1100 kPa). The heat exchanger shall be of 439 grade stainless steel welded construction with a vertical cylindrical counter-flow water tube design complete with integral 439 grade stainless steel finned heat transfer tubes and waterways. The heat exchanger design shall be capable of 40oF constant system return temperatures and have a fully condensing primary and secondary heat

exchanger complete with condensate trap and drains. A pressure relief of valve of 75 psig shall be furnished with the heater.

The gas train shall consist of a pressure regulating electro-hydraulic proportional air/gas main gas actuator providing a slow opening, fast closing shutoff valve and proportional 1:1 air/gas ratio control, a fast closing safety shutoff gas pressure regulator with 1 PSI allowable static pressure, and low and high gas pressure switches. A factory pre-set combination metering valve and orifice shall be provided for setting combustion parameters. Boiler shall operate with a 5:1 turndown ratio.

The combustion air fan draws gas under negative pressure and mixes it with air to generate a fine tuned air gas mixture which is delivered under positive pressure to the radial knitted stainless steel burner. Combustion modulation is established by a variable frequency drive. The burner shall be a 100% stainless steel vertical mounted radial fired type with stainless knitted metal fiber construction. The burner shall combust a precise amount of premixed combustion air and gas to provide equal distribution of heat for heat transfer throughout the entire heat exchanger. Combustion products are exhausted under minimum back pressure. Combustion operates with a 5:1 turn down ratio while sustaining combustion characteristics throughout the entire modulating range. Operation of up to 99% thermal efficiency and shall be certified for Oxides of Nitrogen (NOx) of 9 ppm corrected to 3% oxygen.

The burner combustion shall operate as proportional modulating with a 5:1 turndown ratio with a minimum 20% firing rate. Multiple boiler “Cascade” firing algorithms are proportional modulation. Light off shall be at no more than 50% input to assure rumble free soft start. Combustion shall be optionally suitable for natural gas, propane and dual fuels operation.

Standard controls include a SOLA electronic proportional integrated combination ignition limit/operator control accurate to 10F (0.50C) having a 4-20 mA output signal suitable for control of a variable frequency motor drive or a pulse width modulation signal output for modulating fan speeds. Controls are lead lag “Cascade” ready for control of up to eight boilers c/w Indoor outdoor reset and lead lag control. Control shall be equipped and ready with 4-20 mA remote set point or modulating control, capable with 0-10 VDC remote set point or modulating control. Control is BMS Modbus RTU protocol ready and capable of other alternate protocol conversions with additional optional gateway protocol converter. Control shall be supplied with a mounted touch screen mid level display which shall also provide for control system configuration and set up, readouts of boiler target, differential and inlet/outlet temperatures as well as accumulated runtime, enunciator diagnostics, and firing rates. System control display shall provide full diagnostics including real time data logging and support for up to eight (8) boilers in “Cascade” sequencing application, Modbus ready. The complete control package shall be mounted on the front panel with a hinged door for easy access to all control modules. The boiler safety control string shall be furnished with controls for low gas pressure, optional high gas pressure, fan air proving, blocked flue, water pressure, high limit, stack limit and flow switch. A flow switch shall be provided loose. Additional control safeties shall include flue gas stack temperature, flame rectification, fan speed, and auto recycling high limit.

The ignition module shall employ a proven pilot. Trial for ignition shall proceed with 15 seconds between retrials. Ignition control shall include times for pre-purge, pre-ignition, ignition, and post purge.

The following venting options may be utilized:

1. Category II Venting – single or combined vent*
2. Category IV Outside Air (Horizontal & Vertical)
3. Category IV Through-wall Venting (Horizontal & Vertical)
4. Outdoor Venting
5. Category II & IV Direct Venting

* Category II combined vent shall only employ an engineered designed vent system prepared by a certified vent manufacturer

The following category II and IV optional vent materials shall be utilized

1. Stainless or AL29-4C for all system applications
2. PPE or polypropylene for all system applications
3. PVC for select low temperature systems only – consult factory
4. CPVC for domestic hot water systems and select low temperature systems

All venting shall be through the roof, roofing repair shall be included.

The external jacket shall be of 430 stainless steel mirror finish panels and a powder paint coated access top cover assembled utilizing interference fit locks and minimal non-strip self tap screws for ease of removal and access to the heat exchanger and combustion air / gas control.

Voltage shall be 120 volt.

Boilers shall be Camus, Thermal Solutions, Hydrotherm, RBI or equal.

1.15 WATER TREATMENT:

Water treatment work shall be executed under the direct supervision of an independent water treatment company with personnel experienced in hydronic and steam system water treatment having an experience record of not less than five (5) years in the water treatment industry. System cleaning and treatment work shall not be done by the installing contractor without the proper supervision.

A certificate of completion of the system cleaning and treatment shall be provided by the Water Treatment Company.

The heating and cooling equipment shall not be fired nor shall the circulating water systems be operated prior to cleaning and treatment.

The Water Treatment Company shall provide a description of the water treatment and glycol in the individual systems and shall mount the descriptions with heavy plexiglass covers on the wall adjacent to the chemical feeder for each respective system.

Acceptable Water Treatment Companies meeting the above requirements are as follows:

Fremont Industries
EcoLab
Girton-Adams

Independent Water Treatment Companies not listed above must submit for approval. This approval is not required prior to the bid; however, must be completed prior to any treatment work being done and is at the sole discretion of the Architect/Engineer.

Cleaning and Flushing:

All boilers, heating and cooling circulating water system piping, and equipment shall be thoroughly flushed out with cleaning chemicals at a temperature of 140 degrees F. to remove all pipe dope, oils mill scale, and other extraneous materials. Cooling circulating water systems may be flushed and cleaned without heating the system to 140 degrees F. providing the treatment used is applicable to low temperature cleaning. The system may require multiple cleaning and flushing of the system to accomplish adequate low temperature cleaning and flushing. The system shall then be filled immediately with clean water and flushed, refilled with clean water to which water chemical treatment shall be added in the prescribed dosage.

Circulating Water System Treatment (Heating and Cooling):

Chemical feeding equipment for closed systems shall be a filter feeder with 5 gallon capacity. The filter feeder shall be rated at 200 psi and 212 degrees F. Filter bags shall be 5 micron filters with 1.95 square feet filter area. Feeder drain shall be routed to the nearest floor drain. Filter feeder shall be Garrett-Calahan Company Model FTF-5, Neptune FTF-5, Wingert or equal.

Provide a one (1) year's supply of liquid polymeric corrosion inhibitor treatment for the prevention of corrosion in closed systems at 20 ppm total phosphate level. Systems with 25 percent by volume or greater concentrations of specially inhibited glycol may not require additional corrosion inhibitor.

Service and Control:

The water treatment company shall provide the services of a fully qualified service representative for one year at no additional cost to the Owner. This service representative must have been active in the water treatment field for a minimum of five years.

The water treatment company shall train the operating personnel as to the proper testing procedures and applications of his products for proper treatment.

The water treatment company shall make technical service visits to the site of the Owner to perform field inspections and to make water analyses on site, both of such complexity as to evaluate the water systems operations. The service representative shall provide findings to the proper personnel in writing on proper practices, chemical treating requirements, and any corrective actions needed to protect the water systems from scale, corrosion, and fouling.

Chilled Water Systems: May and August.

Heating Water Systems: November and February.

The water treatment company shall be on call at no additional cost to the Owner to make on site inspections of equipment during scheduled or emergency outages in order to properly evaluate the success of the water treatment program, and to make recommendations in writing based upon these inspections.

1.16 GAS SERVICE:

Outside gas service to the meter location shown on the Drawings along with the gas meter and pressure regulator, will be installed by the Local Gas Company. Any costs for installation and/or relocation of outside gas service shall be paid by the Contractor, and this cost shall be included in the Contractor's Base Bid.

1.17 AUTOMATIC TEMPERATURE CONTROL:

Install the automatic temperature control valves, openings for water monitoring devices, flow switches, wells, alarms and control devices as provided by the Automatic Temperature Control Contractor. These valves and devices shall be installed under the direct supervision of the Section 230900, AUTOMATIC TEMPERATURE CONTROL Contractor and in strict accordance with the manufacturer's recommendations.

1.18 CALIBRATED BALANCE VALVE:

Furnish and install a Bell & Gossett Circuit Setter or equal calibrated balance valves of the sizes shown on the Drawings. Valves 3 inch size and smaller shall be Model CB and over 3 inches shall be Model OP. Each valve setter shall be of bronze construction for 125 psi and 250 degrees F.

Each valve in cold piping shall have an extended operator stem with insulation sleeve and extended pressure/temperature test ports to accommodate the pipe insulation and vapor barrier.

All valves shall include a balance valve either integral with the calibrated balance valve or immediately downstream from the flow fitting.

Calibrated Balance Valves shall be Bell & Gossett, Taco, Gerand, Flowset, Presco, Victaulic, Nexus, Pro Hydronics or equal.

1.19 AUTOMATIC FLOW CONTROL VALVES:

Contractor shall provide and install Griswold, AutoFlow or equal Automatic Pressure compensating Automatic Flow Control Valves where shown on the Drawings. Contractor shall provide replacement cartridges as necessary for system balancing.

Automatic Flow Control Valves (FCV) shall automatically control flow rates with +/- 5% accuracy over an operating pressure differential range of at least 14 times the minimum required for control. Two operating pressure ranges shall be available with the minimum range requiring less than 3 PSID to actuate the mechanism. Valve internal control mechanism shall consist of a

passivated stainless steel one-piece cartridge with segmented port design and full travel linear coil spring. Dual pressure or pressure/temperature test valves for verifying the pressure differential across the cartridge and system temperature shall be standard. Manufacturer shall provide certified independent laboratory tests verifying accuracy of performance.

Ball Valves integral to the automatic flow control valves shall be made of Bronze and rated for 600 WOG.

P/T Adapter for supply side shall include a pressure/temperature test valve for measuring temperature and/or pressure differential across the terminal unit. Provide a metal identification tag with chain for each installed valve. The tag shall be marked with zone identification and rated flow in gpm.

All components shall be warranted by manufacturer for no less than five years from date of purchase.

Correct flow shall be verified by establishing that the operating pressure differential across the valve tappings is within the range indicated on the submittal data sheet for that model number.

Each valve in cold piping shall have an extended operator stem with insulation sleeve and extended pressure/temperature test ports to accommodate the pipe insulation and vapor barrier.

Automatic Flow Control Valves shall be Griswold, Autoflow, Nexus, Pro Hydronics or equal.

1.20 PRESSURE REDUCING VALVE:

Furnish and install a Bell & Gossett Model B7 pressure reducing valve or equal. The valve shall be installed in the fill line to the hydronic and steam systems. The valve shall have an anti-siphon check valve and a built-in strainer. Valve shall be adjustable from 8 to 25 psig, 3/4 inch size.

Pressure Reducing Valve shall be B&G, Taco or equal.

1.21 REDUCED PRESSURE BACKFLOW PREVENTER:

Furnish and install Watts Regulator Co. Series No. 009-S, 909-S or equal reduced pressure backflow preventer. Where shown, the backflow preventer shall be a complete assembly including tight-closing shut-off valves before and after the device and also be protected by a strainer. The design shall include test cocks and a pressure-differential relief valve located between two positive seating check valves.

The device shall meet the requirements of A.S.S.E. Standard 1013 and A.W.W.A. Standard C506. Unit vent outlet shall have a suitable connection for an air gap and shall be provided with an air gap fitting piped to a floor drain.

Reduced pressure backflow preventers shall be Watts, Hersey, Febco, Conbraco, Wilkins or equal.

1.22 HEATING AND COOLING SYSTEMS COIL DAMAGE PROTECTION:

Furnish and install Dow Chemical Company Dowfrost HD or equal specially inhibited propylene glycol-based fluid in the heating and cooling circulating water systems to minimize the risk of coil damage.

Circulating heating water systems shall incorporate 25 percent propylene glycol by volume.

Circulating chilled water systems shall incorporate 30 percent propylene glycol by volume.

Specially inhibited glycol shall be Dow Chemical Company, Union Carbide or Interstate Chemical Company.

1.23 TESTS:

General:

The Contractor shall furnish a competent individual familiar with the installation to assist the Balancing Company and make the necessary mechanical equipment adjustments as directed by the Balancing Company. The Contractor shall also furnish the necessary ladders, scaffolding, etc., needed for access to test and balance all systems.

The Contractor shall provide replacement pulleys, etc. as required to properly balance the heating equipment.

The following tests shall be performed on the respective systems. Tests shall be repeated until each system is proven acceptable.

Heating and Cooling:

The Contractor shall make an operating test of the heating and chilled water systems and all relating equipment.

At a time set by Contractor and agreed to by the Owner, the Contractor shall arrange to place the heating plant in operation and have available at that time representatives of the manufacturers of the equipment to assist in starting of the heating plant and to make necessary adjustment to equipment, and to prove satisfactory operation prior to turning over to the Owner.

The operating test shall cover a total running period of 24 hours and all pertinent data shall be presented to the Owner as an indication of the proper operation of the plant.

The Contractor shall cooperate with and assist the independent Testing and Balancing Company specified in Section 230800 - VENTILATION AND AIR CONDITIONING to properly balance the water flow to and from all coils and equipment and make any adjustments necessary to meet the required flows.

All piping systems installed by the Contractor shall be tested with a pressure equal to 150 percent of the normal operating pressure for the specific systems (100 psi minimum).

END OF SECTION 220600

SECTION 220700 – PLUMBING AND HEATING INSULATION AND PIPING IDENTIFICATION

1.01 SCOPE:

The GENERAL, SUPPLEMENTAL and other CONDITIONS of the Contract and the GENERAL REQUIREMENTS (Division 1) are hereby made part of this Section.

Section 220100, General Provisions, in its entirety, including references to the General Construction Specifications are hereby adopted and made part of these specifications.

The work involved in this specification and the accompanying Drawings consists of performing all labor and furnishing of all labor, materials, fixtures, and equipment necessary to install complete piping, and equipment insulation as described herein and/or as shown on the Drawings. This includes all equipment and materials obviously necessary for complete systems though not specifically mentioned or shown.

1.02 MATERIALS AND WORKMANSHIP:

All covering and insulating materials used on this project must contain the manufacturer's name on the containers. All materials must be dry and in good condition, free of defects, mildew, rough ends, etc. Insulation materials shall be Certainteed, Owens-Corning, Johns Manville, Armstrong, Knauf or equal.

All insulation work shall be performed by an Insulation Contractor who uses workers skilled in this type of work. Only first class workmanship will be acceptable. The Insulation Contractor shall submit shop drawings for all materials proposed to be installed in this project.

All pipe covering shall have a density of not less than 3-1/2 pounds per cubic foot.

All materials shall have composite fire and smoke hazard ratings as tested by procedures ASTM 84, NFPA 255, AND U.L. 723 not to exceed 25 Flame Spread and 50 Smoke Developed.

1.03 PIPING AND VESSELS INSULATION:

All pipe covering shall be furnished with a factory-applied all service jacket. All longitudinal joints shall be sealed with adhesive such as Benjamin Foster 30-35, or equal, or factory applied self-sealing laps. All end joints shall be sealed with 3 inches wide butt strips of material identical to pipe covering jackets, using adhesive or self-sealing jacket. No stapling will be permitted on any vapor-barrier jackets. No vapor-barrier work or self-sealing laps or lap work shall be installed when temperatures are below 40 degrees F.

Cover with 30 mil PVC cover in all exposed areas except mechanical rooms. PVC cover shall have solvent welded joints and seams.

Insulation shall be continuous through properly sized wall and floor sleeves with no joints within 12 inches of the penetration. Where a fitting is adjacent to the wall a continuous section of insulation must extend from the fitting to 12 inches beyond the other side of the wall.

Wrap pipe at penetrations of fire or smoke barriers with firestop pipe insulation, seal jacket seam and seal end joints to adjacent sections of insulation. Seal opening between insulation and pipe sleeve with firestopping material.

All plastic, fiberglass or other piping and fittings that are not rated for unprotected installation in return air plenums shall be wrapped with 3M Fire Barrier Plenum Wrap 5A+, or equal. The installation shall be in strict accordance with the manufacturer's written instructions. Wrap shall be a high temperature fiber blanket thermal insulation encapsulated in a fiberglass reinforced aluminum foil. Plenum wrap density shall be nominal 6 pcf and have a nominal ½ inch minimum thickness. The fiberglass blanket shall have a continuous use limit in excess of 1832 degrees F (1000 degrees C). Flame Spread Index and Smoke Developed Index of the foil encapsulated blanket shall be equal to or less than 25/50.

All piping exposed to outdoor weather conditions shall be additionally covered with 30 mil PVC jacket sealed watertight. PVC cover shall have solvent welded joints and seams.

All insulation installations shall conform to ASHRAE Standard 90.

1.04 FITTING AND EQUIPMENT INSULATION:

Insulate all fittings, valves, flanges and strainers with mitered segments of pipe insulation wired in place and premolded PVC plastic covers. Plastic covers shall be taped and sealed with a continuous vapor barrier on all cold systems. Plastic covers shall be Zeston or equal.

The Contractor shall allow for the removal and replacement of four (4) fitting or joint covers selected by the Architect/Engineer for inspection purposes. If any of the removed covers reveal unsatisfactory installation as determined by the Architect/Engineer, four (4) additional covers may be removed and replaced. Fitting covers may be removed and replaced four (4) at a time until the system installation is satisfactory.

For fittings where premolded PVC plastic covers are not available, coat each fitting with two 1/8 inch coats of an approved vapor-barrier mastic such as Childers CP-30 or equal. Reinforce each fitting by wrapping with glass fabric cloth extending 2 inches onto adjacent pipes and finish with additional coating of mastic worked into mesh of cloth to provide a smooth finish.

Coat vapor barrier penetrations, including insulation end butts, piping brackets, valve operator stems, etc., with two 1/8 inch coats of an approved vapor-barrier mastic. Trim the insulation at valve handle operators to allow for valve operation without damaging the vapor barrier. Insulation mastic for cold systems shall be Childer's CP-30 or equal for cold system vapor barriers. Vapor barrier shall be rated at 0.02 perms or less in accordance with ASTM E96 procedures.

Corner beads shall be used on all square corners.

Insulation shall be cut or mitered where necessary to fit the contour of the fittings and equipment. All voids shall be packed with light density glass fiber insulation. Insulation sections shall be banded in place with 3/4 inch x 0.015 inch thick galvanized steel bands at 18 inch o.c. for all large equipment. Insulation shall be covered with one inch galvanized hexagonal wire mesh. Apply 1/2 inch of insulating cement such as OC-110 or equal in 2 layers over the wire mesh.

On all cold systems, insulation shall be impaled over welding pins at 12 inches o.c. and secured in place with speed washers. The 3/4 inch steel bands will not be required. Each layer of insulation shall have a
vapor barrier cover to provide complete airtight envelope. Vapor-barrier shall consist of one layer of Ludflow foil barrier paper smoothly adhered to the insulation cement surface with vapor-barrier lap adhesive. Lap all joints a minimum of 3 inch and seal with vapor-barrier lap adhesive.

Apply 30 mil PVC cover over vapor barrier in all exposed areas except mechanical rooms. PVC cover shall have solvent welded joints and seams.

1.05 HOT PIPING AND VESSELS:

The following systems shall be insulated with the following minimum thicknesses of glass fiber insulation:

MINIMUM PIPE INSULATION – INTERNATIONAL ENERGY CONSERVATION CODE & ASHRAE 90.1
Based on thermal conductivity (k) of 0.23 btu-in./hour-ft^2-°F
on a flat surface at 75° F. mean

	Fluid	Insulation Thickness for Pipe Sizes					
Piping System Types	Temp. Range Deg.F.	1" & Under	1-1/4" to 1 1/2"	2"	2-1/2" to 4"	5 to 6"	8" & Over
Hot Water Heating Systems -							
Low Temp	120-200	1.0	1.0	1.5	1.5	1.5	2.0
Domestic Systems -							
HW, RHW	Any	1.0	1.0	1.0	1.5	1.5	1.5

Do not insulate radiation runouts enclosed in radiation cover and risers between floor and radiation cover.

The following equipment shall be insulated with thicknesses as noted of calcium silicate blocks such as OCF, Kaylor or equal:

Heating System Air Separator . . 2"

Convertor insulation may be high temperature insulating blanket suitable for temperatures up to 1200°F.

1.06 COLD PIPING AND VESSELS:

The following systems and services shall be insulated with the following thicknesses of glass fiber insulation including a factory-applied all service jacket and vapor barrier:

	Pipe Sizes	
	½" through 2"	2-1/2" to 12"
Domestic CW, downspouts, cooling coil drains	1/2"	1"
Chilled water, supply and return	1"	1-1/2"

Insulate all roof drain bodies and seal with vapor-barrier adhesive.

All rods for pipe hangers and metals having direct contact with cold water piping shall be insulated up to 8 inches and sealed same as fittings. Refer to Section 220100 for cold water pipe supports. Pipe hangers shall not be in direct contact with cold piping unless approved by the Architect/Engineer.

Pipe mounting brackets for cold piping shall be large enough to encompass the insulation. This piping shall be anchored securely at the point of connection to plumbing fixtures. The last mounting bracket adjacent to fixtures and equipment may clamp directly onto the pipe. A short length (18 inches maximum) of piping between the last bracket and the plumbing fixture is allowed without insulation.

The following equipment shall be insulated with thickness as noted of rigid, 6 pound density, glass unfaced fiberboard such as OCF Type 705 or equal:

	Pipe Sizes	
	2" & under	2-1/2" & larger
Roof drain bodies		1"
Chilled water pumps	1"	1 1/2"
Chilled water air separator	1"	1-1/2"
Recirculation pump	1"	1-1/2"

NOTE TO SPECIFIER: Add additional special equipment specific to this project.

Only the pump body and not the motor shall be covered on all pumps.

Insulation thicknesses based on thermal conductivity (k) of 0.23 btu-in./hour-ft^2-°F on a flat surface at 75°F.

Insulation greater than 2 inch thickness shall be installed in layers with staggered joints.

1.07 PIPING IDENTIFICATION:

Identify all piping, insulated and uninsulated, except where concealed inside walls or below floors, with 1 inch high black letters designating the type of service and an arrow in the direction of flow. The lettering shall be applied after all painting of the piping is complete as specified in Division 9 - FINISHES. The lettering shall have an identifying word or phrase such as, cold water, gas, sprinkler, low pressure steam return, etc. Each pipe shall be identified at 30 feet intervals maximum and at each change in direction.

Identify all valves using a metal tag, except small isolating valves, that is, reheat coil shutoff valves, sink stops, radiator valves, etc., immediately adjacent to equipment served. The tags should tell the function of the valve or have a number relating to the function. If numbers are used and there is more than one of the same type valve, subnumbers may be used. For example, a tag labeled CW-2 would mean the second cold water valve on the system. Provide the Owner with two (2) copies of the master list showing the valve numbers, their location and what they control. Metal tags shall be 1-1/2 inch x 3 inch rectangular tags or 2 inch diameter circular tags.

To standardize the lettering and abbreviations, use the following listing:

Domestic Cold Water - (CW).

Hot Water - (HW).

Recirculating Hot Water (RHW).

Vent (Vent).

Downspout (DS).

Waste (W).

Heating Water Supply (HWS).

Heating Water Return (HWR).

Chilled Water Supply (CHS).

Chilled Water Return (CHR).

Sprinkler (SPR).

Gas (GAS).

END OF SECTION 220700

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DIVISION 23 – VENTILATION AND AIR CONDITIONING

SECTION 230100 - GENERAL PROVISIONS

1.01 SCOPE:

The GENERAL, SUPPLEMENTAL and other CONDITIONS of the Contract and the GENERAL REQUIREMENTS (Division 1) are hereby made part of this Section.

This Section pertains to general provisions and requirements for construction of work specified in all sections of Division 23 herein.

"Contractor" referred to in this Section of the specification implies the Contractor, Subcontractor and/or Subcontractors which are responsible for all or any part of the mechanical installation specified in Division 23 and/or as shown on the Contract Drawings.

Where the specifications in subsequent Sections of Division 23 conflict with requirements of this Section, the specifications in the subsequent Sections shall govern.

The Contractor shall provide all items, articles, materials, operations or methods listed, mentioned or scheduled on the Drawings and/or herein specified, including all labor, materials, equipment, accessories, wiring and incidentals necessary to be installed in accordance with manufacturer's recommendations except as otherwise approved.

1.02 PERMITS AND SERVICE CHARGES:

All permits and service charges necessary for execution of the work under this Contract shall be obtained by and be paid for by the Contractor. It shall be the responsibility of the Contractor to determine the permit requirements of the local authorities and utility companies and the cost of required permits, service charges, tap fees and development fees shall be included in the Contractor's bid.

All work shall be executed in accordance with all local, state and national rules, regulations, codes, etc., which are applicable and shall be subject to inspection by the proper authorities.

1.03 CODES AND STANDARDS:

All work performed and all equipment furnished under this Division of the Contract shall be manufactured and installed in strict accordance with all applicable codes and standards, including the applicable provisions of the following codes and standards.

1. Local and State Codes, Standards and Regulations.
2. National Fire Protection Association (NFPA).
3. National Electric Code (NEC).
4. Underwriter's Laboratory (UL).
5. American Gas Association (AGA) Standards.
6. Uniform Plumbing Code.
7. International Mechanical Code.
8. ASME Boiler and Pressure Vessel Codes.
9. State Boiler Safety Code.

10. American Waterworks Association (AWWA).
11. National Sanitation Foundation (NSF).
12. Williams-Steiger Occupational Safety and Health Act of 1970 (OSHA).
13. International Building Code.
14. Life Safety Code.
15. State Energy Conservation Standards.
16. Americans with Disabilities Act (ADA).

All materials installed shall have composite fire and smoke hazard ratings as tested by procedures ASTM 84, NFPA 255 and UL 723 not to exceed 25 Flame Spread and 50 Smoke Developed.

1.04 COMPLIANCE:

Where specific requirements of any code vary with the requirements of another code, the higher standard as determined by the Architect/Engineer shall govern the installation.

All equipment manufactured in accordance with the provisions of the above codes and standards shall bear the label of the respective association bureau thereon.

1.05 DRAWINGS:

In general, the Drawings of the mechanical systems and equipment are to scale. However, to determine exact locations of walls and partitions, the Contractor shall consult the architectural and/or structural drawings which are dimensioned. Drawings shall not take precedence over field measurements.

Drawings of piping and ductwork, although shown on scale drawings, are diagrammatic only. They are intended to indicate size and/or capacity where stipulated, approximate location and/or direction, and approximate general arrangement of one phase of work to another, but not the exact detail or exact arrangement of construction. If it is found, before installation of any or all construction phases, that a more convenient, suitable or workable arrangement of any or all phases of the project would result by varying or altering the arrangement indicated on the Drawings, the Architect/Engineer may require the Contractor to change the location or arrangement of the work without additional cost to the Owner. Such rearrangement shall be in accordance with directions from the Architect/Engineer.

Where discrepancies are discovered after certain portions or phases of the work have been installed, the Architect/Engineer reserves the right to require the Contractor to make changes in pipe, duct, fixture or equipment locations or arrangements to avoid conflicts with work at no additional cost to the Owner.

Because the Drawings are to a relatively small scale to show as large a portion as is practical, the fact that only certain features of the system are indicated does not mean that other similar or different features or details will not be required. The Contractor shall furnish all incidental labor, material or equipment for the systems so that each system is a complete and operating one unless otherwise specifically stipulated in the detailed body of the specifications.

The Contractor, Subcontractor's and their respective trades shall cooperate in laying out their work so it will fit properly into the space provided. Promptly report to the Architect/Engineer any delay or difficulties encountered in the installation of this work which might prevent prompt

and proper installation, or make it unsuitable to connect with or receive the work of others. Failure to so report shall constitute an acceptance of the work of other trades as being fit and proper for the execution of this work.

1.06 SUBSTITUTIONS AND PRODUCT OPTIONS:

The Contractor and equipment suppliers shall read and familiarize themselves with articles concerning substitution of materials, as indicated in the Instructions to Bidders. Material and equipment substitutions will be handled as follows:

Materials or equipment specified by name of manufacturer, brand, trade name or catalog reference, shall be furnished under the contract unless changed by Addenda or a Contract modification. Where two (2) or more materials are named, the choice of these shall be optional with the Contractor.

Material or equipment followed by the phrase "or equal" shall establish a standard of required function, dimension, appearance and quality to be met by any proposed substitute. No substitution will be considered unless written request for substitution has been submitted by the bidder and has been received by the Architect/Engineer at least ten days prior to the date for receipt of bids. The Architect/Engineer's decision on a proposed substitute shall be final. If the Architect/Engineer considers any proposed substitution equal, such will be set forth in an Addendum. Bidders shall not rely upon substitutions made in any other manner.

Should the Contractor wish to use materials or equipment other than those specified or listed as equal by Addenda, he shall attach his proposed substitution along with the appropriate add or deduct to the Contract amount, should the substitution be accepted. Substitutions proposed by the Contractor will not be considered in the award of the Contract.

1.07 SHOP DRAWINGS:

Refer to the requirements of the General Conditions. Unless indicated otherwise in the General Conditions, submit to the Architect/Engineer seven (7) copies (minimum) of Shop Drawings for each item of equipment to be installed under this contract with two (2) copies to be retained by the Architect/Engineer. Furnish additional Shop Drawings as required for coordination with General Contractor and other Subcontractors.

To the extent practical, complete sets of shop drawings for each specification section shall be submitted. In the case that a particular item is required to be expedited, that particular item may be submitted individually.

Submit shop drawings punched in 3-hole format.

Furnish Shop Drawings as follows:

1. For all major items of equipment or materials, regardless of whether the item is to be furnished as specified.
2. For all equipment, systems or devices where Shop Drawings are specifically called for.
3. For all minor items of equipment or materials where the Contractor proposes to deviate from the specified and/or scheduled manufacturer or material.

The Contractor shall check all Shop Drawing submittals for size, capacity, arrangement, connection locations, materials, finish, color, electrical characteristics, accessories, and shall so note the Shop Drawings prior to submittal to the Architect/Engineer. Any deviation from the Drawings and Specifications shall be indicated.

Shop Drawings will be reviewed by the Architect/Engineer, and copies of Shop Drawings will be returned to the Contractor. Shop Drawings shall be submitted sufficiently in advance of the construction schedule to allow time for checking Drawings, resubmittal and rechecking when necessary.

Any equipment or material which is installed without authorization by properly processed Shop Drawings will be subject to removal by the Contractor and reinstallation as directed, without cost to the Owner. All cost for repair for damages as may be incurred to the structure as a result of the above correction shall be paid by this Contractor.

Shop drawing material quantities will not be checked by the Architect/Engineer, and review of Shop Drawings by the Architect/Engineer shall not be construed to be verification of the material quantities and sizes shown on the Shop Drawings. Quantities, sizes, dimensions and locations shown on the Drawings and as specified shall determine material requirements.

1.08 CLEANING:

The Contractor and/or Subcontractors for the various phases of the work shall clear away all debris, surplus materials, etc., resulting from their work or operations, leaving the job and equipment furnished under any or all contracts in a clean first class condition.

Permanent heating and ventilating systems shall not be used during the construction period unless the project site is in a clean and dust free condition and shall be subject to the approval of the Architect/Engineer and Owner.

Air surfaces of all coils, fan housings, fan wheels, fan motors, air unit plenums, all air filters, and mechanical equipment shall be wiped clean or washed if required, leaving the installation in a first class condition. All throwaway filters used during construction shall be replaced.

The surfaces of all equipment shall be cleaned, and each item shall be left in a first class condition.

1.09 PAINTING:

Painting of materials and equipment furnished under the mechanical portion of the contract shall be as described in Division 9 - FINISHES. Contractor shall refinish and restore to the original condition and appearance, all mechanical equipment which has sustained damage to the manufacturer's prime and finish coats of enamel or paint. Materials and workmanship shall be equal to the requirements described in Division 9 - FINISHES.

1.10 RECORD DRAWINGS:

The Contractor shall keep a complete set of all mechanical drawings in the jobsite office for purpose of showing the installation of mechanical systems and equipment. This set of drawings shall be used for no other purpose. Where any materials equipment or system components are

installed different from that shown on the Architect/Engineer's drawings, such differences shall be clearly and neatly shown on this set of drawings using ink or indelible pencil. At the completion of the project, the record set of drawings shall be turned over to the Architect/Engineer and shall become his property.

1.11 OPERATING INSTRUCTIONS:

The Contractor shall furnish the Owner two (2) sets of complete catalog data, manufacturer's literature and detailed manuals covering the operation and maintenance of all equipment specified under this Division. All such literature shall be bound in an amply sized three-ring binder and submitted to the Architect/Engineer for approval and for eventual transmittal to the Owner. The manual shall have a Table of Contents at the front of the manual.

The Contractor shall also supervise the initial operation of all equipment and instruct the operator selected by the Owner in such operation as required to acquaint him thoroughly with the equipment.

1.12 DELIVERY AND STORAGE OF MATERIALS:

Make provisions for delivery and safe storage of materials on the jobsite and make arrangements with other Contractors for introduction into the building of equipment too large to pass through finished openings. Materials to be delivered at such stages of the work as will expedite the work as a whole and marked and stored in such a way as to be easily checked and inspected. All stored equipment shall be protected from the weather conditions and construction debris with a protective covering securely tied in place.

1.13 MECHANICAL PROVISIONS:

Mechanical equipment shall operate without objectionable noise or vibration, as determined by the Architect/Engineer. If such noise or vibration should be produced and transmitted to occupied portions of the building by apparatus, ducts, or other parts of the mechanical work, make necessary changes and additions, as approved, without extra cost to Owner.

Provide oil level gauges, grease cups and grease gun fittings for machinery bearings as recommended by the manufacturer. Extend oil or grease fittings by copper tubing to readily accessible locations.

1.14 CONCRETE BASES:

Concrete bases are required for floor mounted mechanical equipment inside buildings and are specified in Division 3 - CONCRETE. After bases are poured they shall set at least seven (7) days before mounting equipment. The Contractor shall coordinate the setting of expansion bolts in the bases for attachment of equipment and/or isolators.

This Contractor shall verify and coordinate the exact location of the bases and the exact size requirements for specific items of equipment.

Indoor chillers, condensers, air handling units, fans and other floor mounted mechanical equipment shall be mounted on four inch (or as required) high concrete bases.

1.15 COORDINATION OF WORK:

The Contractor shall process shop drawings and order equipment and materials expeditiously after receiving the Contract and the mechanical installation shall be substantially complete when the general construction work is completed. This Contractor shall confer and cooperate with all other Contractors on this project and shall arrange his work in proper relation to the work of others. Each Contractor shall furnish, install, and maintain in place all anchors, inserts, sleeves, etc., required for his work. Each Contractor will also be held solely responsible for proper size and location of all anchors, inserts, sleeves, chases, recesses, openings, bases, etc., required for proper installation of his work. All cutting and patching made necessary by failure or neglect to coordinate with other Contractors shall be the responsibility of this Contractor. Any cutting or patching shall be subject to the direction and approval of the Architect/Engineer and all damage due to cutting or patching shall be repaired by this Contractor.

After being instructed by this Contractor to do so, the General Contractor will leave all openings in roof, walls, floors, etc., for the passage of ducts, etc. The General Contractor shall also provide concrete bases and roof curbs where shown for mounting the mechanical equipment unless specified otherwise. This Contractor shall verify the exact size and location required for installation of his equipment with the General Contractor.

In general, the Division 26 – Electrical Contractor will provide all power wiring and make one power connection to each item of mechanical equipment, as outlined under Electrical Section.

1.16 GUARANTEE:

All mechanical equipment including equipment used during construction for temporary purposes shall be guaranteed for a period of one year after the time of final acceptance of this work and shall be in like new condition at time of final acceptance.

1.17 TEMPORARY HEAT:

The building ventilation and air conditioning systems shall not be used for temporary heating purposes without written approval of the Architect/Engineer.

Use of the building permanent heating and ventilating systems prior to substantial completion is subject to the written approval of the Architect/Engineer and extended warranties shall be provided at no additional cost.

Duct systems shall not be used during construction without the written approval of the Architect/Engineer. Systems used during construction without written approval, may be required to be professional cleaned or replaced at no cost, as determined by the Architect/Engineer.

1.18 ELECTRICAL:

Electric Motors:

All electric motor driven equipment being furnished and installed under Division 23 of these specifications shall be complete with electric motors, unless specified otherwise.

All electric motors shall be as manufactured by Westinghouse, Century, Wagner, Allis Chalmers, Reliance, General Electric, or equal. Bearings shall be ball type with alemite lubricating fittings extended to an easily accessible location for field servicing. Minimum service factors for all motors shall be 1.15. All motors shall conform to applicable NEMA standards and all motors specified for use in hazardous locations shall bear the stamp of approval of the Underwriter's Laboratories. All motors, except direct connected motors, shall be furnished complete with cast iron or stamped steel adjustable slide rails. Single phase motors shall be capacitor start type, drip proof, unless specified otherwise. All motors shall be single speed and shall operate at 1,750 RPM, unless specified otherwise.

Horsepower Rating: All electric motors shall be sized to meet the horsepower requirements of the driven unit at design characteristics including all V-belt and/or drive and coupling losses which are incurred without loading the motor beyond its nameplate horsepower rating. Where V-belt drives are employed, the motor horsepower nameplate ratings shall not be less than 120 percent of the driven unit brake horsepower requirements.

Single Phase Motors: Unless specifically noted otherwise, all electric motors shall be designed for operation in an ambient temperature not exceeding 40 degrees C., continuous duty and shall be designed for use with voltage as scheduled on Drawings or specified, 60 cycle alternating current. Motors shall be thermally protected.

Three Phase Motors: All electric motors shall be designed for operating in an ambient temperature not exceeding 40 degrees C., continuous duty and shall be designed for use with voltage as scheduled on Drawings or specified, 60 cycle alternating current.

All motors less than 3/4 horsepower shall be 115 volt, single phase unless designated otherwise and all motors 3/4 horsepower and larger shall be as specified in the specific section or as noted on the Drawings.

Two Speed Motors:

Two speed motors shall have two separate windings.

Premium Efficiency Motors:

Premium efficiency motors shall be furnished on all mechanical equipment where 1 horsepower or larger motors are required.

Motors shall be designed with special stator steel for reduced core losses. Windings shall be oversized copper placed for maximum efficiency. Stator and rotor shall be extra long to reduce flux losses. Frame shall be ODP (unless specified otherwise) of cast iron or cast aluminum construction.

Motors shall be squirrel cage, horizontal base mount, ball bearing, NEMA B design, Class B design, Class B insulation, continuous duty, 1.15 SF, 40 degrees C. ambient.

Minimum nominal full load motor efficiencies shall be based on ASHRAE Standard 90 (latest edition).

Furnish and install Aegis SGR, or equal, maintenance free, circumferential, conductive micro

fiber shaft grounding rings on all AC motors controlled by adjustable frequency drives to discharge shaft currents to ground.

Motors shall be similar to Louis Allis "Spartan" Series, Gould "E-Plus" Series, or Westinghouse "MAC II" Series. Manufacturer shall furnish proof of efficiency rating.

Motor Starters:

Except where specifically described as being furnished as a part of the equipment furnished and installed under Division 23 of these specifications, all motor starters will be furnished and installed under Division 26, ELECTRICAL.

Electrical Wiring:

Except where specifically described as being furnished as a part of the equipment furnished and installed under Division 23, all electric power wiring shall be furnished and installed in Division 26, ELECTRICAL. The Electrical Contractor will make one power connection to each item of mechanical equipment, unless specified otherwise.

Electrical wiring furnished and installed under these specifications shall conform to all applicable requirements of Division 26, ELECTRICAL.

Unless otherwise indicated, all motors and controls shall be furnished, set in place and wired in accordance with the following schedule:

Item	Division Furnished Under	Set in Place or Mounted Under	Division Wired & Connected Under
Equipment Motors	23	23	26
Magnetic Motor Starters:			
Automatically controlled, with or without HOA switches	26	26	26
Automatically controlled, with or without HOA switches and furnished as part of factory wired equipment	23	23	26
Manually controlled	26	26	26

Manually controlled and furnished as part of factory wired equipment	23	23	26
Line voltage thermostats, time clocks, etc., not connected to control panel systems	23	26	26
Electric thermostats, time clocks, remote bulb thermostats, float controls, etc., which are an integral part or directly attached to ducts, etc.	23	23	23
Temperature control panels and time switches mounted on temperature control panels	23	23	23
Damper motors, solenoid valves, EP and PE switches, etc.	23	23	23
Smoke damper operators	23	23	23
Alarm bells	23	23	23
Control circuit feeders	26	26	26
Low voltage controls, thermostats, valves, dampers, etc.	23	23	23
Fire and smoke detectors, including relays for fan shutdown	26	26	26(1)
Pushbutton stations, pilot lights	26	26	26

Heat tape	26	26	26
Disconnect switches, thermal overload switches, manual operating switches	26	26	26
Multi-speed switches	23	26	26
Contactors	26	26	26
Control relays, transformers	23	26	26

NOTES:

(1) Wiring from alarm contacts to alarm system shall be by the Division 26 Contractor; control function wiring shall be by the Division 23 Contractor.

All control wiring and controls as noted on the Drawings and/or as specified in these specifications shall be provided by this Contractor, including items set in place and wired and connected by the Division 26 Contractor, unless specifically shown otherwise on the Drawings.

1.19 SLEEVES:

Any pipe passing through building construction including walls, floors, roofs or masonry partitions or as noted on the Drawings shall be encompassed with sleeves in accordance with the following:

All pipe sleeves through slabs, floors, masonry walls and masonry partitions shall be 1/2 inch greater in inside diameter than the external diameter of pipe passing through. Sleeves for insulated piping shall be large enough to accommodate the insulation without harming the insulation or vapor barrier. All sleeves shall be fabricated from new material cut square and reamed.

Sleeves shall be provided in all masonry partition walls including locations above suspended ceilings where masonry partition walls extend from floor slab to slab above. Sleeves shall be Schedule 40 steel pipe finishing flush with the wall surface.

Sleeves through exterior building walls shall be Schedule 40 steel pipe with welded flange in the middle of the sleeve and ends finishing flush with finished surfaces. Space between pipe and sleeve shall be packed to provide a watertight joint.

Sleeves through roof slabs and floor slabs in concealed locations shall be No. 22 gauge galvanized steel or crete sleeves (linear polyethylene). Concealed sleeves shall be considered as pipe sleeves in shafts, pipe chases and within walls and partitions.

Sleeves through floor slabs in exposed areas shall be Schedule 40 steel pipe and sleeves shall extend 1/4 inch above the finished floor surface. For slabs in equipment rooms and in other wet areas, sleeves shall be Schedule 40 steel pipe and shall extend 2 inches above finished floor surface.

Floor sleeves in membraned floors shall be furnished with flashing rings and clamps.

All sleeves in exposed locations, except equipment rooms, shall be set so plates specified will cover the sleeves.

All pipe sleeves where wet conditions exist, except sleeves through exterior walls, shall be caulked with a plastic caulking, including sleeves in concealed locations. The space between the pipe and the sleeves shall be packed with oakum and approximately 1/2 inch depth of a polyisobutylene
sealer shall be packed or caulked in both ends of sleeve, even with the ends of the sleeve. The sealer shall be suitable for temperatures from minus 50 degrees to 300 degrees, suitable for painting, non-corrosive and have good adhesion.

Sleeves in fire rated construction, equipment rooms, and/or where designated on the Drawings shall consist of 22 gauge galvanized sheet steel with lock seam joints. Seal sleeves with a fire retardant sealant. When applied according to manufacturer's recommendations, sealant shall have a 3-hour U.L. fire rating.

All sleeves required to provide the proper openings in masonry construction for the passage of ductwork, mechanical equipment, etc., shall be furnished and installed by this Contractor. These sleeves shall also be removed by this Contractor after the opening has been formed. The opening around all ductwork, equipment, etc., passing through slabs, floors, walls and partitions shall be sealed as specified above for piping. Fire/smoke dampers shall be installed in accordance with the manufacturer’s installation instructions.

All sleeves shall be set and maintained in place by this Contractor during the progress of the work. This Contractor shall be responsible for locating all sleeves at the proper location.

Sleeves are not required for core drilled masonry wall and floor holes, masonry wall and floor holes formed by polyethylene plastic (removable) sleeves, or for masonry holes made in another neat manner except in equipment rooms and other wet areas.

Sleeves are not required in metal or wood stud wall construction. Rated systems shall be provided as required to provide the necessary rating of the penetration.

Interior wall sleeves are only required on cold insulated piping (refrigerant suction piping, etc.). All other steel or cast iron piping 4 inches and smaller shall be grouted directly into the wall as necessary to provide the required fire and smoke rating. Piping larger than 4 inch size and all non-rated piping shall be provided with a rated system.

Firestopping materials shall be 3M, Hilti, MetaCaulk, Nelson or equal.

1.20 WALL, FLOOR AND CEILING PLATES:

Furnish and install chrome-plated wall, floor and ceiling plates on all exposed pipes where they pass through walls, floors, or ceilings in finished areas. Finished areas shall be those areas which are painted or have special finishes within the room. The wall plates shall be a minimum of 3/32 inch thickness and shall have set screws or spring locks for clamping to the piping. The plates shall be chrome-plated steel, cast iron or brass and shall set tight against the wall.

1.21 EQUIPMENT SUPPORT:

Furnish and install all necessary wall backing, brackets, braces, plates, angles, wall hangers, etc., required for properly supporting mechanical equipment and mechanical appurtenances. All supports shall be securely anchored with lead inserts, expansion shields, through-going bolts, lag screws or other devices as required.

All items of mechanical equipment hung from overhead structure shall be hung from 2-1/2 inches by 2-1/2 inches by 3/16 inch angles minimum which shall span at least 3 members, unless noted otherwise.

1.22 EXISTING SERVICES:

The Contractor shall verify the exact location of all existing building services extended and/or relocated for this project. The Contractor shall also verify the exact location and take proper precautions to protect all services which may be encountered during construction.

All active services which are encountered shall be protected, braced and supported where required for proper execution of the work and without interruption of the service if possible.

All inactive services which are encountered shall be protected or removed as directed by the Architect/Engineer, Owner, Utility Company or Municipal Agency having jurisdiction. The service shall also be plugged or capped as directed.

When active services must be temporarily interrupted, the interruption shall be scheduled at night or at such time as approved by the Owner or authority having jurisdiction and so as to cause the minimum of interference with establishing operating routine. Arrangements shall be made to work continuously including overtime if required, to assure that services will be interrupted only as long as actually required to complete necessary work.

1.23 EXCAVATION:

Trenching and excavation for all underground piping and equipment shall be excavated to the required depths. The bottom of the excavation shall be tamped hard and graded to secure the required fill. Rock, where encountered, shall be excavated to a depth of 6 inches below the bottom of duct or pipe and before duct or pipe is laid, the space between bottom of pipe and rock surface shall be filled with gravel.

After the installation has been tested, inspected and approved by the Architect/Engineer and prior to backfilling, the forms shall be removed and the excavation shall be cleaned of trash and debris. Materials for backfilling shall consist of the excavation, or borrow of sand or gravel, and shall be free of trash, lumber, or other debris. Backfill shall be placed in horizontal layers, not exceeding 9 inches in thickness, and properly moistened. Backfill inside the building and under any exterior slabs or other paved areas shall be compacted by hand or mechanical means to the density of 95

percent Proctor and areas outside the building not covered by concrete slabs or other structures or pavement shall be compacted to the density of the adjacent undisturbed soil. Any settling within the one (1) year guarantee period shall be repaired at no cost to the Owner.

1.24 ACCESS TO EQUIPMENT:

Access shall be provided to all motors, valves, dampers, controls, specialties, etc., for maintenance purposes. All access doors, access panels, removable sections, etc., required for access shall be provided. The location of the access openings relative to the mechanical equipment shall be coordinated to assure proper access to the equipment. The door shall maintain any ratings of the wall, ceiling, etc. that it penetrates.

Access openings are required for valves, manual, motorized, fire, and smoke dampers and other devices requiring access and shall be provided in the ductwork, plenums, housings, tanks, walls, ceilings, etc., under this portion of the Contract.

1.25 PROTECTIVE DEVICES:

All sheaves, belts, drives, couplings, and moving parts shall be protected by approved permanent guards, shields, or railings, which shall be in place whenever the equipment is in operation and shall be in accordance with applicable safety standards.

All pressure and/or temperature relief valves shall have the discharge piped full size to within 6 inches of the floor or floor drain. The piping shall be securely anchored. All relief valves shall be ASME approved and proper size for the application.

1.26 PIPING CONNECTIONS:

Furnish and install unions or mating flanges at all connections to each piece of equipment, conveniently located to facilitate quick and easy disconnecting of equipment for replacement, tube cleaning or general maintenance. Flanged or union connections shall be used on both sides of equipment. Unions or flanges shall be of the same material or finish as the piping systems in which they are installed. Unions are not required for grooved pipe systems.

Dielectric unions, flanges, or waterways shall be installed where copper or brass piping is connected to ferrous material. Dielectric unions 2 inch size and smaller shall be steel body and nut with insulating gasket and copper connector, 250 psi rating at 190 degrees F., EBCO Model FX, FB, or EA. For 2-1/2 inch size and larger, the union shall be flanges, cast iron with insulated gasket and copper connector, 175 psi rating at 190 degrees F., EBCO Model GX or GA.

1.27 FLEXIBLE CONNECTORS:

Furnish and install flexible connectors on all piping connections to rotating equipment such as fans, AHUs etc., and where shown on the Drawings. Flexible connectors shall also be installed at all locations where necessary to prevent damaging stresses to piping, equipment, or building structure, and where necessary to isolate noise at its source.

Flexible connectors for refrigerant piping shall be close pitch annular corrugated phosphor bronze hose and bronze braid for refrigerant piping and non-ferrous piping systems, Flexonics Type PCB or equal.

Flexible connectors shall be installed in strict accordance with manufacturer's recommendations and shall be constructed of material specified herein, unless recommended otherwise by the manufacturer for specific applications.

Flexible Connectors shall be Kinetics, Proco, Mercer, Flexonics, Twin City Hose, Inc. or equal.

1.28 PIPE HANGERS, SUPPORTS AND ANCHORS:

Anchors as shown and detailed on the Drawings and specified herein and/or as required. All support components shall conform to Manufacturer's Standardization Society Specification SP-58. The hangers shall adequately support the piping system. They shall be located near or at changes in piping direction
and at concentrated loads. They shall provide vertical adjustment to maintain pitch required for proper drainage. They shall allow for expansion and contraction of the piping. On other than vapor barrier insulated lines, hangers shall bear directly on piping.

Hangers shall be constructed of malleable or wrought iron unless noted otherwise, and hangers supporting copper pipe shall be copper plated. Hangers for pipe 3 inches and smaller shall be band and socket Michigan Model No. 100 or equal. For piping over 3 inches, hangers shall be adjustable, Clevis type, Michigan Model No. 400 or equal.

Where groups of three or more pipes occur, they may be supported with trapeze hangers using two hangers as specified with a capped pipe cross member.

Where clearance between pipe and overhead support is insufficient for the use of other hangers specified, use Michigan Model No. 605 or equal.

Horizontal steel piping shall be supported as follows:

Pipe Size	Rod Diameter	Maximum Spacing
Up to 1-1/4 inch	3/8 inch	8 feet
1-1/2 inch & 2 inch	3/8 inch	10 feet
2-1/2 inch & 3-1/2 inch	1/2 inch	15 feet
4 inch & 5 inch	5/8 inch	15 feet
6 inch	3/4 inch	17 feet
8 inch through 12 inch	7/8 inch	22 feet

Horizontal copper piping shall be supported as follows:

Pipe Size	Rod Diameter	Maximum Spacing
Up to 1 inch	3/8 inch	6 feet
1-1/4 inch & 1-1/2 inch	3/8 inch	8 feet
2 inch	3/8 inch	9 feet
2-1/2 inch	1/2 inch	9 feet
3 inch & 4 inch	1/2 inch	10 feet

For vertical piping, where supports are not indicated on the Drawings, support steel and copper pipe at every other floor, support PVC piping at every floor and at 5 feet intervals between floors.

Pipe hangers shall not be attached to the roof deck. Hangers shall be attached to the structure with beam clamps, beam attachment and brackets bolted to joists and beams. Use Michigan Model No. 340 or equal, steel washer plates for pipe supported from steel joist. The Contractor shall endeavor to hang near joist panel joints wherever possible.

Pipe hangers for cold piping, refrigerant suction piping and all insulated piping on trapeze hangers shall be large enough to encompass the insulation, using a metal shield so the vapor barrier jacket will not be broken. See Insulation Section.

Pipe mounting brackets for cold piping shall be large enough to encompass the insulation B-Line Model B2417 or equal. This piping shall be anchored securely at the point of connection to equipment. The last mounting bracket adjacent to equipment may clamp directly onto the pipe. A short length (18 inches maximum) of piping between the last bracket and the connection is allowed without insulation.

Hanging from one pipe to another is prohibited.

Pipe Hangers shall be Michigan, Grinnell, PHD, B-Line or equal.

1.29 PIPING INSTALLATION:

All pipes shall be round and straight, of required size. Cutting shall be done with proper tools and pipes shall be reamed to full size after cutting.

Piping shall be properly enclosed, supported, guided, anchored, sway braced, connected, tested, cleaned and flushed out and shall be properly insulated and protected where required.

All pipes shall be run with proper grade to provide for easy draining and in group runs where applicable and in a neat and orderly manner, to the satisfaction of the Architect/Engineer. Lines required to be enclosed in ceiling, chaseways or similar spaces shall be installed to permit such enclosure as intended. All pipe runs shall be carefully laid out and scheduled to avoid necessary interferences with other work. Pipe sizes shown on the Drawings are nominal pipe sizes and not outside diameters.

Pipes shall be run substantially as indicated on the Drawings. However, the Architect/Engineer reserves the right to require this Contractor to make changes in pipe locations where conflicts occur with other trades. Such changes shall be made without extra cost to the Owner.

Piping shall be installed with ample provisions for expansion and contraction to prevent injury to the same and to the building construction. Such provision shall be made by means of piping offsets, changes in direction, expansion loops and/or suitable expansion joints. Suitable anchors and guides shall be provided to permit proper deflection and compression of offset loops and expansion joints. Expansion joints shall not be used in lieu of offsets, changes in direction or loops, except where specified and/or indicated on the Drawings or where otherwise obviously necessary.

Exposed piping shall be installed in a sanitary manner for ease in cleaning.

Equipment piping shall also include wastes and drains which are safe-wasted without a direct connection.

Minimum grade for horizontal drainage piping shall be 1/4 inch per foot for 3 inch diameter piping or less, 1/8 inch per foot for 4 inch and 6 inch diameter piping and 1/16 inch per foot for drainage piping over 6 inch diameter.

END OF SECTION 230100

SECTION 230700 - INSULATION AND PIPING IDENTIFICATION

1.01 SCOPE:

The GENERAL, SUPPLEMENTAL and other CONDITIONS of the Contract and the GENERAL REQUIREMENTS (Division 1) are hereby made part of this Section.

Section 230100, General Provisions, in its entirety, including references to the General Construction Specifications are hereby adopted and made part of these specifications.

The work involved in this specification and the accompanying Drawings consists of performing all labor and furnishing of all labor, materials, fixtures, and equipment necessary to install complete piping, ductwork, and equipment insulation as described herein and/or as shown on the Drawings. This includes all equipment and materials obviously necessary for complete systems though not specifically mentioned or shown.

1.02 MATERIALS AND WORKMANSHIP:

All covering and insulating materials used on this project must contain the manufacturer's name on the containers. All materials must be dry and in good condition, free of defects, mildew, rough ends, etc. Insulation materials shall be Anco, Certainteed, Owens-Corning, Johns Manville, Armstrong, Knauf or equal.

All insulation work shall be performed by an Insulation Contractor who uses workers skilled in this type of work. Only first class workmanship will be acceptable. The Insulation Contractor shall submit shop drawings for all materials proposed to be installed in this project.

All pipe covering shall have a density of not less than 3-1/2 pounds per cubic foot.

All materials shall have composite fire and smoke hazard ratings as tested by procedures ASTM 84, NFPA 255, AND U.L. 723 not to exceed 25 Flame Spread and 50 Smoke Developed.

1.03 PIPING AND VESSELS INSULATION:

All pipe covering shall be furnished with a factory-applied all service jacket. All longitudinal joints shall be sealed with adhesive such as Benjamin Foster 30-35, or equal, or factory applied self-sealing laps. All end joints shall be sealed with 3 inches wide butt strips of material identical to pipe covering jackets, using adhesive or self-sealing jacket. No stapling will be permitted on any vapor-barrier jackets. No vapor-barrier work or self-sealing laps or lap work shall be installed when temperatures are below 40 degrees F.

Insulation shall be continuous through properly sized wall and floor sleeves with no joints within 12 inches of the penetration. Where a fitting is adjacent to the wall a continuous section of insulation must extend from the fitting to 12 inches beyond the other side of the wall.

Wrap pipe at penetrations of fire or smoke barriers with firestop pipe insulation, seal jacket seam and seal end joints to adjacent sections of insulation. Seal opening between insulation and pipe sleeve with firestopping material.

All piping exposed to outdoor weather conditions shall be additionally covered with 30 mil PVC jacket sealed watertight. PVC cover shall have solvent welded joints and seams.

All insulation installations shall conform to ASHRAE Standard 90A-1980.

1.04 FITTING AND EQUIPMENT INSULATION:

Insulate all fittings, valves, flanges and strainers with mitered segments of pipe insulation wired in place and premolded PVC plastic covers. Plastic covers shall be taped and sealed with a continuous vapor barrier on all cold systems. Plastic covers shall be Zeston or equal.

The Contractor shall allow for the removal and replacement of four (4) fitting or joint covers selected by the Architect/Engineer for inspection purposes. If any of the removed covers reveal unsatisfactory installation as determined by the Architect/Engineer, four (4) additional covers may be removed and replaced. Fitting covers may be removed and replaced four (4) at a time until the system installation is satisfactory.

For fittings where premolded PVC plastic covers are not available, coat each fitting with two 1/8 inch coats of an approved vapor-barrier mastic such as Childers CP-30 or equal. Reinforce each fitting by wrapping with glass fabric cloth extending 2 inches onto adjacent pipes and finish with additional coating of mastic worked into mesh of cloth to provide a smooth finish.

Coat vapor barrier penetrations, including insulation end butts, piping brackets, valve operator stems, etc., with two 1/8 inch coats of an approved vapor-barrier mastic. Trim the insulation at valve handle operators to allow for valve operation without damaging the vapor barrier. Insulation mastic for cold systems shall be Childer's CP-30 or equal for cold system vapor barriers. Vapor barrier shall be rated at 0.02 perms or less in accordance with ASTM E96 procedures.

Corner beads shall be used on all square corners.

Insulation shall be cut or mitered where necessary to fit the contour of the fittings and equipment. All voids shall be packed with light density glass fiber insulation. Insulation sections shall be banded in place with 3/4 inch x 0.015 inch thick galvanized steel bands at 18 inch o.c. for all large equipment. Insulation shall be covered with one inch galvanized hexagonal wire mesh. Apply 1/2 inch of insulating cement such as OC-110 or equal in 2 layers over the wire mesh.

On all cold systems, insulation shall be impaled over welding pins at 12 inches o.c. and secured in place with speed washers. The 3/4 inch steel bands will not be required. Each layer of insulation shall have a
vapor barrier cover to provide complete airtight envelope. Vapor-barrier shall consist of one layer of Ludflow foil barrier paper smoothly adhered to the insulation cement surface with vapor-barrier lap adhesive. Lap all joints a minimum of 3 inch and seal with vapor-barrier lap adhesive.

1.05 HOT PIPING AND VESSELS:

The following equipment shall be insulated with thicknesses as noted of calcium silicate blocks such as OCF, Kaylor or equal:

Breeching . . . . . 2"

Boiler breeching insulation may be high temperature insulating blanket suitable for temperatures up to 1200°F. Apply a 22 gauge aluminum cover on the boiler breeching insulation.

1.06 DUCT INSULATION - EXTERNAL:

All exhaust and relief ductwork routed through cold spaces, and all outdoor air ductwork and combustion air ductwork shall be insulated with 1-1/2 inches of external insulation. All round supply air ductwork, except exposed round ductwork in conditioned spaces, shall be insulated with 1 inch of external insulation.

Insulate all drip pans and ducts through the roof or sidewalls with 1 inch of external insulation. All ducts through the roof or sidewalls shall be insulated for a minimum distance of 4'0" laterally from the opening. This shall apply to all relief and exhaust air openings.

External duct insulation in exposed locations shall be 3 pound density Owens-Corning Fiberglass FSK for cold equipment down to minus 60 degrees F., or equal. Insulation shall be cut to fit between standing seams and stiffeners and shall be secured to ductwork by impaling over pins located not more than 12 inches o.c. or more pins if necessary to provide a tight fit to the ductwork. All joints shall be tightly butted and taped. Cover all pin penetrations and all joints with OCF joint sealing tape or equal. Take special care in applying the tape to prevent dust from fouling the tape. The complete installation of external duct insulation shall follow the instructions of the manufacturer of the insulation used. Complete system shall be U.L. rated and meet NFPA Fire Hazard Classification.

External duct insulation in concealed locations shall be 1 pound density Owens-Corning Fiberglass Faced Duct Wrap Series ED 100 FRK-25, or equal. Insulation shall be wrapped tightly on the duct work with all circumferential joints butted and longitudinal joints overlapped a minimum of 2 inches. Adhere insulation to metal with 4 inch strips of insulation bonding adhesive at 8 inch o.c. Additionally secure insulation to the bottom of rectangular duct work over 24 inches wide with mechanical joints, the 2 inch flange of the facing shall be secured using 9/16 inch flare-door staples applied 6 inches o.c. and taped with minimum of 3 inch wide foil reinforced kraft tape. On longitudinal joints, the overlap shall be secured using 9/16 inch flare-door staples applied 6 inch o.c. and taped with minimum 3 inch wide foil reinforced kraft tape. All pin penetrations or punctures in facing shall also be taped.

Wrap duct at penetrations of fire or smoke barriers with firestop insulation, seal jacket seam and seal end joints to adjacent sections of insulation. Seal opening between insulation and sleeve with firestopping material.

1.07 DUCT INSULATION - INTERNAL:

All rectangular supply and return ductwork shall be insulated with 1 inch of internal insulation.

Internal duct insulation shall be Owens-Corning Fiberglass Duct Liner or equal, 1-1/2 pound density, and have a thermal conductivity of 0.28 at 75 degrees F. mean temperature. The surface shall be coated with a black fire-resistant neoprene coating meeting NFPA 90A Standards and shall have no air erosion of the fibers with air velocities up to 6,000 fpm. Increase duct size to accommodate liner. Adhere liner, with coated side towards air stream, to all interim sides of duct

with 100 percent coverage of fire resistant insulation bonding adhesive such as Benjamin Foster No. 81-20, 3M spray adhesive No. 77, or equal. When duct width or height exceeds 20 inches for horizontal ducts and 12 inches for vertical ducts, further secure the liner to these surfaces with mechanical fasteners at 15 inch o.c. Top pieces shall be supported by the side pieces. All edges and joints shall be coated with adhesive.

Velocities - 2,000-4,000 fpm: For all ducts exceeding 16 inches in height and 12 inches width, further secure the liner to these surfaces with mechanical fasteners at 15 inch O.C. The dimensions shall be reduced to 12 inches for vertical ducts.

Velocities - 4,000-6,000 fpm: Install as above except that mechanical fasteners shall be spaced 12 inches o.c. on all surfaces and metal noising shall be installed to secure liner at all upstream traverse edges.

1.08 PIPING IDENTIFICATION:

Identify all piping, insulated and uninsulated, except where concealed inside walls or below floors, with 1 inch high black letters designating the type of service and an arrow in the direction of flow. The lettering shall be applied after all painting of the piping is complete as specified in Division 9 - FINISHES. The lettering shall have an identifying word or phrase such as, cold water, gas, sprinkler, low pressure steam return, etc. Each pipe shall be identified at 30 feet intervals maximum and at each change in direction.

To standardize the lettering and abbreviations, use the following listing:

Refrigerant (R-22).

END OF SECTION 230700

SECTION 230800 - VENTILATION AND AIR CONDITIONING

1.01 SCOPE:

The GENERAL, SUPPLEMENTAL and other CONDITIONS of the Contract and the GENERAL REQUIREMENTS (Division 1) are hereby made part of this Section.

Section 230100 General Provisions, in its entirety, including references to the General Construction Specifications are hereby adopted and made part of these specifications.

The work involved in this specification and the accompanying Drawings consists of performing all labor and furnishing of all materials, fixtures and equipment necessary to install complete ventilation and air conditioning systems as described herein and/or as shown on the Drawings. This includes all ductwork, equipment, wiring and materials obviously necessary for complete systems though not specifically mentioned or shown.

See Section 230700 for insulation requirements.

1.02 DUCTWORK:

All ductwork is to be galvanized iron fabricated and erected in a workmanlike manner. Fabricate plenums and special fittings, as shown on the Drawings, or as required. Access doors to plenums shall be double wall construction with heavy hardware. All ductwork shall be of the gauges hereinafter specified and constructed to the best grade Inland, U.S. Steel, United Sheet Metal or equal brands, heavily galvanized.

Metal gauges for low and medium pressure duct systems shall be of metal gauges and reinforcing as recommended by SMACNA or as follows:

Maximum Dimension of Rectangular Ducts or Diameter of Round Low Pressure Ducts	Galvanized Sheet Steel Gauge Number
Up thru 12"	26
Over 12" thru 30"	24
Over 30" thru 54"	22
Over 54" thru 84"	20
Over 84"	18

Maximum Dimension of Rectangular Ducts or Diameter of Round Medium Pressure Ducts	Galvanized Sheet Steel Gauge Number
Up thru 18"	24
Over 19" thru 48"	22
Over 49" thru 72"	20
Over 73" thru 96"	18

Ductwork shall be constructed, braced, reinforced and sealed as recommended by ASHRAE and SMACNA. Environmental air ductwork as defined by the International Mechanical Code shall be substantially air tight. Low pressure ductwork shall be suitable for pressures up to 2 inch w.g. Medium pressure ductwork shall be suitable for pressures up to 3 inch w.g. All ductwork 18 inches and greater in width shall be cross-broken. See SMACNA requirements for proper sealing of ductwork. All supply air ductwork between VAV air handling units and VAV terminals shall be medium pressure construction.

Ductwork with the longest side 36" wide and over shall be constructed using Ductmate 35/25 or equal slide on systems, per Ductmate Industries Installation Procedures and Duct Construction Standards, latest edition. The non-proprietary SMACNA T-22 Flanged Connection may be used as defined on Page 1.63, 1.64 and 1.80, of the 1995 SMACNA Manual, Second Edition. The non-proprietary T-24, proprietary TDC/TDF flanges and Ductmate 35/25 may be used for transverse joint construction, 35" wide and smaller. Ductmate 440 Butyl Gasket, or equal, shall be used between all rectangular transverse flanged duct connections, Ductmate's 440 Butyl Gasket, shall be used with the Ductmate Systems. For rectangular ductwork located outdoors, exposed to weather, construct ductwork per, "Transverse Joints Rectangular" with a continuous metal cleat on top joints of ducts for added weather protection. Slide on systems shall be Ductmate, Ward Industries, Inc., or equal.

No obstruction shall be permitted in the ductwork to retard the flow of air. If it is necessary to run a pipe or conduit through a duct, the duct size shall be increased to compensate for the obstruction.

Where space permits, duct turns shall be constructed with an inside radius equal to or greater than the duct width or duct turn vanes may be used. Where space does not permit duct turns as described above, duct turn vanes shall be used. Where space permits, duct offsets 30 degrees and greater shall be constructed with an inside radius equal to or greater than the duct width.

Where interior duct insulation is required, increase the duct size to maintain the free area shown on the Drawings.

Provide exterior insulated drip pans, 3 inches deep, under or adjacent to all roof and wall openings including but not limited to under all intake or relief hoods and louvers. Drip pans to be soldered watertight.

Power operated dampers not furnished as a component of the ventilating machines will be furnished under the Temperature Control Specifications. They shall be installed in the ductwork under this specification. Caulk around all sides of high efficiency damper frames.

Flexible connections shall be installed between suction and discharge openings in fan units and the ducts with which they are connected as shown on the Drawings, to prevent transmission of vibration noises. Material shall be watertight and fire retardant canvas weighing not less than 20 ounces per square yard, or shall be glass fabric on high temperature systems where fire hazard exists. Both materials shall be approved by Underwriter's Laboratories. The flexible material shall be furnished with all necessary angles, bolts, clips or other fasteners.

Furnish and install access panels in the ductwork adjacent to all motorized dampers, fire dampers, louvers, reheat coils, and equipment which may require servicing or cleaning. Panels shall be tight fitting and shall be located so as to make them easily accessible. All panels installed in

insulated ductwork shall be double wall, insulated type. Panels shall be Ruskin, Air Balance, Ventlok, ADCO, or equal.

Dynamic rated fire dampers shall have an 18 inch square access panel or an 18 inch long removable duct section shall be installed adjacent to dynamic rated fire dampers in addition to a smaller inspection access panel. The removable section shall be assembled using Ductmate or equal duct joints. The joint at the damper shall be assembled with plastic fastener clips. Ductwork 24 inches and wider shall have an 18 inch by 18 inch access door in lieu of removable section.

Ductwork installed above UL fire rated ceiling assemblies shall be installed in strict accordance with the provisions required by the UL Design Number designated in the Underwriters Laboratories Fire Resistance Directory.

All ductwork visible through the face of a register or grille shall be painted with a flat black paint.

All rigid and flexible ductwork materials installed shall have composite fire and smoke hazard ratings as tested by procedures ASTM 84, NFPA 255 and UL 723 not to exceed 25 Flame Spread and 50 Smoke Developed.

Concealed low pressure round ductwork may be rigid spiral ductwork or snaplock type with adjustable elbows.

All exposed round ductwork and round ductwork to the inlet of VAV terminals shall be United, Semco, Norlock, Foremost, SMC, SPOT or equal, rigid spiral duct and fittings. Tee fittings shall be factory built tee fittings or equal. Saddle branch takeoff fittings are not acceptable except as approved by the Architect/Engineer.

Round ductwork shall be supported at 6 feet o.c. where building framing does not provide such support. Support shall be minimum 3/4 inch metal strap suspended from the roof or framing.

Flexible duct shall not exceed 8 feet in length or pass through walls. Flexible round ductwork may only be used for final connections to supply registers and diffusers in concealed locations.

All round sheet metal supply air ductwork, except exposed, shall be insulated with 1 inch thick of Owens-Corning Fiberglass Faced Duct Wrap Series ED-100 FRK-25 or equal.

1.03 REGISTERS, GRILLES AND DIFFUSERS:

Furnish and install all registers, grilles and diffusers as specified hereinafter and as designated on the Drawings. Opposed blade, heavy duty dampers shall be used on systems having two or more duct openings where balancing of air discharge or intake is required. Grilles may be used where there is only one opening and where balancing is not required.

Diffusers, registers, and grilles shall be provided as listed in the schedule on the Drawings. All registers, grilles and diffusers shall be of size and capacity with special requirements, frames, dampers, blank-off baffles, etc., as listed in the schedule and as designated. Opposed blade, heavy duty dampers shall be provided on all units unless designated otherwise on the Drawings.

Louver faced ceiling diffusers shall have a minimum of three (3) inner diffuser cones plus the outer shell unless scheduled otherwise.

The installed location of all ceiling diffusers, registers, and grilles shall be as shown on the Reflected Ceiling Plans.

The finish on all aluminum registers, grilles and diffusers shall be etched to a lustrous satin finish and coated with a clear acrylic lacquer, or white finish as noted below and/or on the Drawings. All steel units shall have white enamel finish, unless noted otherwise. Interior of perforated diffusers shall be painted black.

All ceiling mounted registers, grilles and diffusers shall be white unless noted otherwise. All floor mounted registers, grilles and diffusers shall be satin anodized without mounting holes unless otherwise noted.

Ceiling registers, grilles and diffusers in fire rated ceilings shall have an outer cone of 24 gauge (minimum) steel construction and shall have UL Fire Resistance Classified fire dampers with radiation shields.

Registers, Grilles and Diffusers shall be Tuttle and Bailey, Carnes, Anemostat, Titus, J & J Register, Metal Industries, Grillmaster, Krueger, Price, Reliable, Nailor or equal.

1.04 AIR HANDLING UNITS:

Furnish and install (medium) pressure draw-through single zone air handling units as shown and detailed on the Drawings. Units shall be complete with mixing box, air blender, water heating coil, direct expansion or water cooling coil, fan drive and motor and insulated cabinet.

Cabinet shall be of sectionalized construction and fabricated of galvanized steel or steel with an enamel coat finish. The cabinet panels shall be removable for access and shall be internally insulated with 2 inch thick R-13 foam insulation. Cooling coil section shall include drain pan and all coil headers shall be enclosed within the cabinet. Cabinet panels shall be fabricated of standard metal gauges as listed by the manufacturer. Drain pan shall be piped to a floor drain with a water seal trap in the drain piping.

Unit shall be constructed of a complete frame with removable panels. Removal of side panels must not affect the structural integrity of each module. The casing must be able to withstand up to six-inches positive or four-inches negative static pressure with less than 1% leakage and L240 deflection. All exterior wall panels shall be made of minimum 18-gauge G90 galvanized steel. Closed-cell gasketing shall be where modules are joined. The entire unit shall be mounted on a continuous 6 inch high base rail which wraps around all 4 sides. Unit shall be double-wall constructed to prevent fiberglass erosion into the airstream and to allow cleaning of the unit interior. Interior wall shall be 18-gauge perforated plate galvanized steel. Foil faced insulation is not acceptable. Units shall have an insulated, double-wall stainless steel drain pan under cooling coil section(s) for drainage of condensate. Drain connections are to be provided on both sides of the unit. One side shall be piped to a floor drain with a water seal trap. Full sized hinged removable double-wall access doors with two step safety handles shall be provided for quick access to the interior of the unit casing. Doors attached by screws or doors not continuously gasketed and thermally broken are not acceptable. Units shall be factory insulated with 2 inch

thick 1-1/2-pound density insulation. All connecting channels shall be insulated to prevent sweating.

Fans shall be multiblade type and may have backward inclined or airfoil type blades.

Fans shall be dynamically balanced single width, single inlet, direct drive plug fans rated in accordance with AMCA Code No. 210. Fans and motors shall be selected to be capable of 120 percent of nominal speed when controlled by an adjustable frequency drive. Fans shall be mounted on spring type vibration isolators. Fans per air handling unit shall be as shown on the Drawings.

Air mixing boxes for air handling units shall be constructed similar to unit cabinet and shall include interlocked outdoor air and return air dampers, duct flanges, and nylon bushing for the damper rods.

The outside air damper shall be a high efficiency type with less than 1 percent leakage at 2 inches static pressure.

Filters shall be Cambridge, Farr, Continental, AAF, or equal 2 inch pleated throwaway filters. Filter efficiency shall be 30 percent based upon ASHRAE Standard 52-68. Furnish and install magnehelic gauges to measure the pressure drop across the filters. Furnish and install separate gauges for each filter bank. The changeout pressure drop shall be marked.

Air Blenders shall be static mixing devices of the rotary turbulating design, by Blender Products, Inc., consisting of radially extending turbulators. Units shall be completely fixed devices, with no moving parts. Standard fabrication shall be of all welded .080" thick aluminum, .125" on air blenders larger than 96", construction. Steel units shall be epoxy or PVC coated to protect against rust and contaminated air. All units shall be factory built and tested. When multiple blenders are used, they shall impart a counter rotational mixing of the air streams to each other. Simple mixing devices which do not produce expanding radial discharge with counter rotational mixing will not be acceptable. The mixing device shall perform at face velocities from 500 FPM through 2500 FPM with no loss in mixing performance. The complete mixing section shall be constructed with proper mixing distances such that the two airstreams yield a maximum temperature standard deviation through a plane parallel with Blender at the discharge of the mixing section shall be 6 degrees F, and shall provide even airflow and temperature across filters, coils and control thermostats to insure accuracy of averaged temperature reading.

Coils shall be copper tube and aluminum fins mechanically bonded together. Coils shall have galvanized steel casing and water coils shall be drainable type. Coils shall include a vent at the highest point and shall be circuited for counterflow of air and water. Steam coils shall be steam distributing type. Coil face velocity for coils shall not exceed 500 fpm, unless noted otherwise on the schedule. All coil connections
shall be on the same side. All cooling coils shall be ARI Standard 410 (Latest Edition) certified or the coil capacity shall be 120 percent of the cooling BTUH capacity specified. Chilled water cooling coils shall be downstream of the heating coil.

Starters shall be included in Division 26. Motors shall be selected at 120 percent of fan brake horsepower requirements.

Units shall be mounted on spring type vibration isolators as recommended by the manufacturer.

Unit capacities and design conditions shall be as listed in the schedule on the Drawings.

Air Handling Units shall be Trane, McQuay, Carrier, York or equal.

1.05 ADJUSTABLE FREQUENCY DRIVES (7-1/2 HORSEPOWER AND LARGER):

Furnish and install adjustable frequency motor drives consisting of a pulse width modulated (PWM) inverters for use on a standard NEMA Design B induction motors. The drives shall be designed specifically for variable torque HVAC applications, and shall be designated "ACH 500". It is required that the drive manufacturer have an existing:

1. Sales representative exclusively for HVAC products, with expertise in HVAC systems and controls.

2. An independent service organization.

3. A parts stocking depot local to the installation site.

The adjustable frequency drives (AFD's) shall be solid state, with a Pulse Width Modulated (PWM) output waveform (VVI, six-step, and current source drives are not acceptable). The AFD package as specified herein shall be enclosed in a NEMA 1 enclosure, completely assembled and tested by the manufacturer. The AFD shall employ a full wave rectifier (to prevent input line notching), DC Line Reactor capacitors, and Insulated Gate Bipolar Transistors (IGBT's) as the output switching device (SCR's, GTO's and Darlington transistors are not acceptable). The drive efficiency shall be 97% or better at full speed and full load. Fundamental power factor shall be 0.98 at all speeds and loads.

All printed circuit boards shall be completely tested and burned-in before being assembled into the completed AFD. The AFD shall then be subjected to a preliminary functional test, eight hour burn-in, and computerized final test. The burn-in shall be at 104 degrees F (40 degrees C), at full rated load, or cycled load. Drive input power shall be continuously cycled for maximum stress and thermal variation.

AFD's shall be UL Listed. The AFD's shall be designed to meet the requirements of the following standards: IEC 801-2, IEC 801-4, IEC 255-4.

Environmental operating conditions: 0 to 50 degrees C @ 3 kHz switching frequency, 0 to 3300 feet above sea level, less than 95% humidity, non-condensing.

Where required, adjustable frequency drives shall be UL508C Listed for installation in air plenums.

All AFD's shall have the following standard features:

1. All AFD's shall have the same customer interface, including digital display, keypad and customer connections; regardless of horsepower rating. The keypad is to be used for local control (start/stop, forward/reverse, and speed adjust), for setting all parameters, and for stepping through the displays and menus.

2. The AFD shall give the user the option of either (1) displaying a fault, or (2) running at a programmable preset speed if the input reference (4-20mA or 2-10V) is lost; as selected by the user.

3. The AFD's shall utilize plain English digital display (code numbers are not acceptable). The digital display shall be a 40-character (2 line x 20 characters/line) LCD display. The LCD shall be backlit to provide easy viewing in any light condition. The contrast should be adjustable to optimize viewing at any angle.

4. The AFD shall have the ability to automatically restart after an overcurrent, overvoltage, undervoltage, or loss of input signal protective trip. The number of restart attempts and trial time shall be programmable.

5. The AFD shall be capable of starting into a rotating load (forward or reverse) and accelerate or decelerate to setpoint without safety tripping or component damage (flying start).

6. The AFD shall be equipped with an automatic extended power loss ride-through circuit which will utilize the inertia of the load to keep the drive powered. Minimum power loss ride-through shall be one-cycle, based on full load and no inertia. Removing power from the motor is not an acceptable method of increasing power loss ride-through.

7. The customer terminal strip shall be isolated from the line and ground.

8. Prewired 3-position Hand-Off-Auto switch and speed potentiometer. When in "Hand", the AFD will be started, and the speed will be controlled from the speed potentiometer. When in "Off", the AFD will be stopped. When in "Auto", the AFD will start via an external contact closure, and its speed will be controlled via an external speed reference.

9. The drive shall employ three current limit circuits to provide trip free operation:

    a. The Slow Current Regulation limit circuit shall be adjustable from 50% to 110% of the AFD's variable torque current rating. This adjustment shall be made via the keypad, and shall be displayed in actual amps, and not as percent of full load.

    b. The Rapid Current Regulation limit shall be fixed at 140% of the AFD's variable torque current rating.

    c. The Current Switch-off limit shall be fixed at 150% of the AFD's variable torque current rating.

10. The overload rating of the drive shall be 110% of its variable torque current rating for 1 minute every 10 minutes, and 115% of its variable torque current rating for 2 seconds every 10 seconds.

11. The AFD shall have input line fuses standard in the drive enclosure.

12. The AFD shall have a manual speed potentiometer in addition to using the keypad as a means of controlling speed manually.

13. The AFD shall have a DC Line Reactor to reduce the harmonics to the power line.

14. The AFD shall be optimized for a 3 kHz carrier frequency to reduce motor noise. The carrier frequency shall be adjustable by the start-up engineer.

All AFD's shall have the following adjustments:

1. Five (5) programmable critical frequency lockout ranges to prevent the AFD from continuously operating at an unstable speed.

2. PI Setpoint controller shall be standard in the drive, allowing a pressure or flow signal to be connected to the AFD, using the microprocessor in the AFD for the closed loop control; thus eliminating the need for external controllers.

3. Two (2) programmable analog inputs shall accept a current or voltage signal for speed reference, or for reference and actual signals for PI controller. Analog inputs shall include a filter; programmable from 0.01 to 10 seconds to remove any oscillation in the input signal. The minimum and maximum values (gain and offset) shall be adjustable within the range of 0 - 20 mA and 0 - 10 Volts.

4. Six (6) programmable digital inputs for maximum flexibility in interfacing with energy management systems.

5. Two (2) programmable analog outputs proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power, or DC Bus Voltage.

6. Three (3) programmable digital relay outputs. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 amps at 250 VAC; Maximum voltage 300 VDC and 250 VAC; Continuous current rating 2 amps RMS.

7. Seven (7) programmable preset speeds.

8. Two independently adjustable accel and decel ramps. These ramp times shall be adjustable from 1 to 1800 seconds.

9. The AFD shall Ramp or Coast to a stop, as selected by the user.

10. The carrier frequency shall be adjustable by the start-up engineer.

The following operating information displays shall be standard on the AFD digital display. The display shall be in complete English words (alpha-numeric codes are not acceptable):

1. Output Frequency
2. Motor Speed (RPM)
3. Motor Current
4. Calculated Motor Torque
5. Calculated Motor Power
6. DC Bus Voltage
7. Output Voltage
8. Heatsink Temperature
9. Analog Input Values

10. Keypad Reference Values
11. Elapsed Time Meter
12. kWh Meter

The AFD shall have the following protection circuits. In the case of a protective trip, the drive shall stop, and announce the fault condition in complete words (alpha-numeric codes are not acceptable).

1. Overcurrent trip 200% of the AFD's variable torque current rating.

2. Overvoltage trip 130% of the AFD's rated voltage.

3. Undervoltage trip 60% of the AFD's rated voltage.

4. Overtemperature +70 decrees C.

5. Ground Fault.

6. Adaptable Electronic Motor Overload (I^2t). The Electronic Motor Overload protection shall protect the motor based on speed, load curve, and external fan parameter. Circuits which protect the motor only at full speed are unacceptable.

Speed Command Input shall be via:

1. Keypad or manual speed potentiometer; as selected by the user.

2. Two Analog inputs, each capable of accepting a 0-20mA, 4--20mA, 0-10V, 2-10V signal. Input shall be isolated from ground, and programmable via the keypad for different uses.

   Analog inputs shall have a programmable filter to remove any oscillation of the reference signal. The filter shall be adjustable from 0.01 to 10 seconds. The analog input should be able to be inverted, so that minimum reference corresponds to maximum speed, and maximum reference corresponds to minimum speed. The minimum and maximum values (gain and offset) shall be adjustable within the range of 0-20mA and 0-10 Volts.

3. Floating point input shall accept a three-wire input from a Dwyer Photohelic (or equivalent type) instrument.

Accessories to be furnished and mounted by the drive manufacturer.

1. Customer Interlock Terminal Strip - provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external interlocks and start/stop contacts shall remain fully functional whether the drive is in Hand, Auto or Bypass.

2. Door interlocked disconnect switch; padlockable in the "Off" position.

3. Manual transfer to line power via contactors. Include motor thermal overload and fuse or circuit breaker protection while in bypass operation. A three position selector switch to control the bypass contactor and the drive output contactor is to be mounted on the

enclosure door. When in the "Normal" mode, the bypass contactor is open and the drive output contactor is closed. In the "Test" position both contactors are open, and in the "Bypass" position, the drive output contactor is open, and the bypass contactor is closed. The drive output contactor shall also open when a stop command is given, isolating the motor from the drive. Start/stop signals and safety interlocks will work in drive and bypass modes. An automatic bypass shall allow the motor to be switched to bypass automatically when the drive goes into a fault condition, and will not automatically reset.

4. Service contactor (drive input contactor) which provides the ability to service the drive (electrically isolate the drive while in bypass operation without having to remove power from the motor). The service contactor shall open when the drive is switched to bypass, and also be controlled by a switch which is mounted inside the drive enclosure so that its access is limited to service personnel only.

5. A class 20 bimetallic thermal motor overload relay shall be provided to protect the motor in bypass.

Compliance to IEEE 519-1981

1. The AFD manufacturer shall provide calculations, specific to this installation, showing total harmonic voltage distortion is less than 5%. Input line filters shall be sized and provided as required by the AFD manufacturer to ensure compliance with IEEE standard 519-1981, Guide for Harmonic Control and reactive Compensation for Static Power Converters. The acceptance of this calculation must be completed prior to AFD installation.

2. Prior to installation, the AFD manufacturer shall provide the estimated total harmonic distortion (THD) caused by the AFD's. The results shall be based on a computer aided circuit simulation of the total actual system, with information obtained from the power provider and the user.

3. If the voltage THD exceeds 5%, the AFD manufacturer is to recommend the additional equipment required to reduce the THD to an acceptable level.

Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the Architect/Engineer, and a copy kept on file at the manufacturer.

Warranty shall be 24 months from the date of start-up, not to exceed 30 months from the date of shipment. The warranty shall include all parts, labor, travel time, and expenses.

The Adjustable Frequency Drives shall be Asea Brown Boveri (ABB), Graham, Magnetek, Reliance Electric, Toshiba, Trane, Yaskawa, York or equal.

1.06 ADJUSTABLE FREQUENCY DRIVES (5 HORSEPOWER AND LESS):

The adjustable frequency drives (AFD's) shall be solid state, with a Pulse Width Modulated (PWM) output waveform (VVI, six-step, and current source drives are not acceptable). The AFD package as specified herein shall be enclosed in a NEMA 1 enclosure, completely assembled and tested by the manufacturer. The AFD shall employ a full wave rectifier (to prevent input line notching), capacitors and Insulated Gate Bipolar Transistors (IGBT's) as the output switching

device (SCR's, GTO's, and Darlington transistors are not acceptable). The drive efficiency shall be 97% or better at full speed and full load. Fundamental power factor shall be 0.98 at all speeds and loads.

Where required, adjustable frequency drives shall be UL508C Listed for installation in air plenums.

All AFD's shall have the following standard features:

1. All AFD's shall have the same customer interface including digital display, keypad and customer connections; regardless of horsepower rating. The keypad is to be used for local control (start/stop, forward/reverse, and speed adjust), for setting all parameters, and for stepping through the displays and menus.

2. The AFD shall have the ability to automatically restart after an overcurrent, overvoltage, undervoltage, or loss of input signal protective trip.

3. The AFD shall be capable of starting into a rotating load (forward or reverse) and accelerate or decelerate to setpoint without safety tripping or component damage (flying start).

4. The AFD shall be equipped with an automatic extended power loss ride-through circuit which will utilize the inertia of the load to keep the drive powered. Minimum power loss ride-through shall be one-cycle, based on full load and no inertial. Removing power from the motor is not an acceptable method of increasing power loss ride-through.

5. The drive shall employ current limit circuits to provide trip free operation:

   The Current Regulation limit circuit shall be adjustable to 150% of the AFD's variable torque current rating. This adjustment shall be made via the keypad, and shall be displayed in actual amps and not as percent of full load.

6. The overload rating of the drive shall be 120% of its variable torque current rating for 1 minute every 10 minutes.

7. The AFD shall be optimized for 8 kHz carrier frequency to reduce motor noise. The carrier frequency shall be adjustable by the start-up engineer.

All AFD's to have the following adjustments:

1. Two (2) programmable critical frequency lockout ranges to prevent the AFD from continuously operating at an unstable speed.

2. One (1) programmable analog input shall accept a current or voltage signal for speed reference. Additionally, the reference must be able to be scaled so that maximum reference can represent a frequency less than 60 Hz, without lowering the drive maximum frequency below 60 Hz.

3. Five (5) programmable digital inputs for maximum flexibility in interfacing with external devices.

4. One (1) programmable analog output proportional to Frequency, Output Current or Speed Reference.

5. One (1) digital fault relay output. The relay shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 amps at 250 VAC; maximum voltage 300 VDC and 250 VAC; continuous current rating 2 amps RMS. Output must be true form C type contact; open collector outputs are not acceptable.

6. Three (3) programmable preset speeds.

7. Two independently adjustable accel and decel ramps. These ramp times shall be adjustable from 1 to 1800 seconds.

8. The AFD shall Ramp or Coast to a stop, as selected by the user.

The following operating information displays shall be standard on the AFD digital display.

1. Output Frequency
2. Motor Speed
3. Motor Current
4. Output Voltage
5. Analog Input Values
6. Keypad Reference Values

The AFD shall have the following protection circuits. In the case of a protective trip, the drive shall stop and announce the fault condition.

1. Overcurrent trip 315% instantaneous (225% RMS) of the AFD's current rating.
2. Overvoltage trip 130% of the AFD's rated voltage.
3. Undervoltage trip 65% of the AFD's rated voltage.
4. Overtemperature +70 degrees C (ACH501); +85 degrees C (ACH502).
5. Ground Fault
6. Adaptable Electronic Motor Overload (I t). The Electronic Motor Overload protection shall protect the motor based on speed, load curve and external fan parameter. Circuits which are not speed dependent are unacceptable.

Speed Command Input shall be via:

1. Keypad.
2. One analog input capable of accepting a 0-20mA, 4-20mA, 0-10V, 2-10V signal.

Installation shall be the responsibility of the DIVISION 15 Contractor. The Contractor shall install the drive in accordance with the recommendations of the AFD manufacturer as outlined in the installation manual.

Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the Owner, and a copy kept on file at the manufacturer.

All drives with or without the bypass feature shall be by the same manufacturer.

The Adjustable Frequency Drives shall be Asea Brown Boveri (ABB), Graham, Magnetek, Reliance Electric, Toshiba, Trane, Yaskawa, York or equal.

1.07 POWER ROOF VENTILATORS:

Furnish and install power roof ventilators as shown and scheduled on the Drawings and/or as listed in this specification, or equal. Ventilators shall be centrifugal rooftop type with automatic backdraft dampers, bird screens, and aluminum housings, unless noted otherwise. All ventilators shall be direct drive. All centrifugal impellers shall be backward curved type with non-overloading characteristics and tip speed shall not exceed 3,500 fpm, unless noted otherwise. All units shall have AMCA certified capacities at the specified static pressure and shall operate at acceptable sound levels at design conditions. All fans shall have variable speed ECM motors with field adjustment at the motor.

All power roof ventilators shall have either integral motor overload protection and a disconnect switch or a manual motor starter with thermal overloads. All motors shall be mounted on vibration isolators.

Unless noted otherwise, all units shall be mounted on prefabricated sound absorbing curbs a minimum of 8 inches in height above the finished roof line. Curbs shall be provided by the ventilator manufacturer and all curbs shall have 2 inch thermal insulation and shall be sized to allow roof flashing to extend up and under unit on all sides.

Backdraft Damper shall be Ruskin Model BD2/A1, American Warming and Ventilating Model BD-42, Greenheck Model VBD-160 or equal.

Fan capacities shall be as listed in the schedule on the Drawings.

Power Roof Ventilators shall be Penn, Cook, Carnes, Greenheck or equal.

1.08 SQUARE CENTRIFUGAL IN-LINE FAN:

Square Centrifugal In-Line Fans shall be centrifugal direct driven in-line type. The fan housing shall be constructed of heavy gauge galvanized steel and shall include duct mounting collars.

Fan construction shall include two removable access panels located perpendicular to the motor mounting panel. The access panels must be of sufficient size to permit easy access to all interior components.

The fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced.

Motors shall be heavy duty ball bearing type, carefully matched to the fan load and furnished at the specified voltage, phase and enclosure. Motors and drives shall be mounted out of the airstream. Motors shall be readily accessible for maintenance.

Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Bearings shall be selected for a minimum (L50) life in excess of 200,000 hours at maximum cataloged operating speed.

Motors shall be variable speed ECM motors with field adjustment for balancing.

A NEMA 1 disconnect switch shall be provided. Factory wiring shall be provided from motor to the handy box.

All fans shall bear the AMCA Certified Ratings Seal for both sound and air performance.

Each fan shall bear a permanently affixed manufacturer's nameplate containing the model number and individual serial number for future identification.

Square Centrifugal In-Line Fans shall be Penn, Cook, Carnes, Greenheck or equal.

1.09 CEILING/IN-LINE EXHAUST FANS:

Furnish and install ceiling and in-line exhausters where shown on the Drawings. Units shall be complete with centrifugal fans, rubber mounted motor, insulated steel housing, eggcrate aluminum grille, and backdraft damper. Motor shall be 115 volt, single phase with integral motor overload protection.

Fan capacity shall be as listed in the schedule on the Drawings.

Fan RPM shall not exceed 1200 RPM.

Ceiling Exhaust Fans shall be Penn, Pace, Cook, Carnes, Greenheck or equal.

1.10 COMBINATION FIRE AND SMOKE DAMPERS:

Furnish and install Underwriter's Laboratories classified (UL555 and UL555S) combination fire and smoke dampers where shown on the Drawings. Damper shall be built to comply with NFPA Bulletin 90A and have a 1-1/2 hour rating and shall have a Class II leakage classification.

Motor operated damper assemblies shall consist of a motor listed, labeled and tested for use with a Underwriter's Laboratories labeled fire damper. Total assembly shall also be Underwriter's Laboratories classified and labeled as a motorized fire damper for use with smoke detection equipment. Units shall be capable of functioning in either a vertical or horizontal position. The damper operator shall be factory mounted.

Motor shall be a 24 volt or 115 volt AC stall type motor coordinated with the Section 230900 Contractor. On activation of the fire alarm, damper blades shall be tightly closed by a stainless steel closure spring. Unit shall be equipped with fusible links and a stainless steel locking clip.

Dampers shall be sized to match the sheet metal dimensions of internally insulated ductwork and the outside dimensions of ductboard installations. Round fire/smoke dampers should be installed in round ductwork.

Combination Fire and Smoke Dampers shall be American Warming and Ventilating Co., Advanced Air, Ruskin, ACT, Greenheck, Air Balance, Cesco, Nailor, Pottorff or equal.

1.11 FIRE DAMPERS (DYNAMIC RATED):

Furnish and install dynamic rated fire dampers where shown on the Drawings. Dynamic Fire Dampers shall be manufactured, tested and approved in accordance with "U.L. Safety Standard 555 for Fire Dampers -- Fourth Edition; January 30, 1990." Testing of dynamic rated fire dampers shall include the ability of dampers to fully close under airflow conditions. Each damper shall bear a UL approved label verifying its classification as a dynamic rated fire damper (a static rated damper is not acceptable). Damper submittal literature shall include appropriate performance data relative to UL-555, and shall include damper maximum rated flow at 4 in. wg for unducted in-wall or in-floor mounting, and at 8 in. wg for in-duct mounting. Each damper shall possess a 1-1/2 hour fire protection rating in accordance with UL-555, and shall bear a UL label as such. Each damper shall be equipped with a replaceable 165^{o}F (212^{o}F optional) UL-listed fusible link. Each damper shall be appropriate for vertical or horizontal installation as required. Installation of dynamic rated fire dampers shall be in accordance with the damper manufacturer's installation instructions.

Fire dampers shall be UL Classified for use in dynamic systems.

Fire Dampers shall be Style B or C. All rectangular fire dampers shall have 95 percent (minimum) free area and curtain type construction. Fire dampers in ductwork with 1 inch internal insulation may be Style "A". Round fire dampers should be installed in round ductwork.

Dampers shall be sized to match the sheet metal dimensions of internally insulated ductwork and the outside dimensions of ductboard installations.

Fire Dampers shall be Ruskin, Air Balance, Greenheck, National Controlled Air, Cesco, Nailor, Pottorff or equal.

1.12 MANUAL DAMPERS:

Furnish and install splitter dampers and balancing dampers in the ductwork where shown and wherever required to accurately balance the system. Splitter dampers shall be minimum of 20 gauge, rigid to prevent vibration and held securely in place at any setting with heavy lock quadrant.

Balancing dampers in rectangular ductwork shall be Ruskin Model No. MD-35 or equal complete with rigid frame, 16 gauge galvanized steel blades, 8 inch maximum blade width, synthetic bearings and heavy lock quadrant with position indicator.

Manual dampers at branch duct tees shall have integral spin-in fittings. Branch duct dampers and tees of equal or greater size to the main duct shall have an integral shoe type fitting. Balancing dampers shown in round ductwork shall be heavy gauge with a locking quadrant on one side and

a shaft extending through the other side of the duct. Manual dampers with integral takeoff fittings shall be as manufactured by Cardinal Supply, Sheet Metal Connectors, Inc. or equal.

Manual Balancing Dampers shall be Ruskin, Greenheck, Air Balance, Cesco, Pottorff or equal.

1.13 DUCT MOUNTED HEATING COILS:

Furnish and install duct mounted heating coils which shall be sized as shown in the schedule on the Drawings. Coils shall be Trane Type T, ST, or Type W, or equal, designed for hot water and suited for duct installation. Coils shall be single tube seamless copper 5/8 inch OD. Tubes and U-bends shall be combined in a single tube using silver brazing. Supply and return connections shall be 3/4 inch internal
thread. Casings shall be constructed of heavy galvanized steel with provision for fastening securely in the ductwork. Bronze, spring type turbulators shall be furnished, if required to meet capacities needed where water velocities are 4 feet per second or less. Coils shall be tested at 250 psi air pressure under water.

Design criteria for the duct mounted heating coils shall be as shown in the schedule on the Drawings.

Duct Mounted Heating Coils shall be Trane, McQuay, York, Temptrol, Dunham Bush or equal.

1.14 LOUVERS:

Furnish and install Ruskin Model ELF6375DX or equal louvers where shown on the Drawings. Louvers shall be stationary drainable type with a drain gutter in each blade and downspouts in jambs and mullions. Blades shall be contained within a single 6" frame. Louver construction shall be 0.080 inch thick 6063 extruded aluminum alloy frame with integral caulking slots. Blades shall be 0.080 inch thick 6063 extruded aluminum alloy at 37-1/2 degree angle on approximately 6 inch centers. A birdscreen shall be contained within a removable frame.

Louver components (heads, jambs, sills, blades, and mullions) shall be factory assembled by louver manufacturer. Louver sizes too large for shipping shall be built up by contractor from factory assembled louver sections to provide overall size required.

Louver shall be finished with baked acrylic enamel in color selected by the Architect, from a standard color chart.

Louver pressure drop shall not exceed the values shown on the Drawings and shall bear the AMCA seal. All ratings shall be in accordance with AMCA Standard 500 and shall include the effect of the bird screen.

Louvers shall be Airolite, American Warming and Ventilating, Inc., Carnes, Louvers and Dampers, Inc., Arrow, United, Cesco, Ruskin, Dowco, Industrial Louvers, Greenheck, Pottorff, Construction Specialties or equal.

1.15 GAS VENT SYSTEM:

Furnish and install AL 29-4C stainless steel gas venting systems on high efficiency gas fired appliances where required. The systems shall be installed in accordance with the manufactures

Installation and Maintenance Instructions and with all applicable local, regional and national codes.

The factory built special gas vent, gas vent connector and chimney liner systems a shall be tested and Listed by Underwriters Laboratories for use with Listed natural gas or propane gas burning equipment which produces continuous flue gas temperatures of 550°F (degrees Fahrenheit) or less. The system shall be installed and sealed per manufacturers instructions so all joints are gas tight preventing leakage of products of combustion into the building.

The all fuel chimney liner system shall be tested and Listed by Underwriters Laboratories for use with all residential heating appliances when properly insulated with chimney liner insulation.

The vent system shall be fabricated from AL 29-4C stainless steel which is highly suited for use with high efficiency gas burning equipment producing excessive amounts of condensation in the vent.

All joints in the vent system shall be fastened with a closure system and shall to be sealed with factory supplied sealant when used with positive pressure or condensing applications. This closure system shall tested to be gas tight at 2 ½ times the Listed pressure rating of 3" wc.

The vent system shall be Listed by Underwriters Laboratories for installation to total system heights up to sixty feet. The system shall be applicable to all interior installations and pass through combustible exterior roofs or walls using the Listed thimble devices. Venting systems extending exposed to outdoors for more than 3 feet shall have a double wall gas vent system.

When connected to gas burning appliances with a maximum continuous flue gas temperature rating of 550 °F (degrees Fahrenheit), the vent shall be rated for installation adjacent to combustible materials, on a maximum of 2 (two) sides only, at 2" clearance. When connected to higher heat appliances combustible materials must be protected per national codes or installed inside a masonry chimney.

The vent system shall be sized in accordance with the appliance manufacturer's specifications, NFPA 211 Chimneys, Fireplaces, Vents and Solid Burning Fuel Burning Appliances, NFPA54 The National Fuel Gas Code ANSI Z223.1, and ASHRAE recommendations and all applicable local and regional codes.

1.16 BACKDRAFT RELIEF DAMPER:

Furnish and install Ruskin Model BD2/A2 or equal pressure relief dampers where shown on the Drawings. Dampers shall consist of 6063T5 extruded aluminum. Frame thickness shall be 0.09 inches and blade thickness shall be 0.050 inches. Damper blades shall have extruded vinyl edge seals and it shall have zytel bearings. Blades shall be linked to work in unison with blade stops top and bottom.

Damper shall have mill finish unless otherwise noted.

Pressure Relief Dampers shall be Ruskin, Air Balance, Louvers and Dampers, American Warming and Ventilating, Cesco, Greenheck or equal.

1.17 PRV BACKDRAFT DAMPERS:

Furnish and install Ruskin Model BD2/A1, American Warming and Ventilating Model BD-42, Greenheck Model EM-10 or equal backdraft dampers in power roof ventilator curbs where shown on the Drawings. Dampers shall consist of 6063T5 extruded aluminum. Frame thickness shall be 0.09 inches and blade thickness shall be 0.025 inches. Damper blades shall have extruded vinyl edge seals and it shall have zytel bearings. Blades shall be linked to work in unison with blade stops top and bottom. The pressure drop through the backdraft damper shall not exceed 0.10 inches w.c. Pressure drop data shall be submitted with the fan shop drawings.

Damper shall have mill finish unless otherwise noted.

Backdraft Dampers shall be Ruskin, American Warming and Ventilating, Greenheck, Cesco or equal.

1.18 COUNTER BALANCED BACKDRAFT DAMPERS:

Furnish and install Ruskin Model CBD2, American Warming and Ventilating Model BD-41, Dowco Model BRL or equal counter balanced backdraft dampers in gravity relief and exhaust hood curbs where shown on the Drawings. Dampers shall consist of 6063T5 extruded aluminum. Frame thickness shall be 0.09 inches and blade thickness shall be 0.025 inches. Damper blades shall have extruded vinyl edge seals and it shall have zytel bearings. Blades shall be linked to work in unison with blade stops top and bottom.

The damper shall begin to open at 0.01 inches w.c. pressure differential and shall be fully open at 0.06 inches w.c.

Damper shall have mill finish unless otherwise noted.

Counter Balanced Backdraft Dampers shall be Ruskin, Dowco, American Warming and Ventilating, Cesco, Greenheck or equal.

1.19 EXHAUST/RELIEF AIR HOOD:

Furnish and install Loren Cook Model GR or equal, exhaust unit of the size as designated on the Drawings. Unit shall be constructed of 0.051 gauge aluminum cap and 0.080 gauge aluminum base with riveted and welded construction. Unit shall include 1/2 inch mesh aluminum birdscreen and gravity backdraft damper.

Roof curb shall be provided with unit and shall be Loren Cook Type RCG or equal. Roof curbs shall be a minimum of 8 inches above finished roof line and shall include 2 inches of thermal insulation.
Backdraft damper shall be Ruskin Model CBD2, American Warming and Ventilating Model BD-41, Dowco Model BRL or equal.

The hood shall have an extended throat which shall provide 18 inches between the finished roof line and the hood discharge. Extension shall be reinforced for additional height.

Hood size shall be as noted on the Drawings. Hood shall not exceed 0.10 inch w.g. pressure drop for exhaust or 0.05 for relief at rated capacity. Exhaust velocity shall not exceed 1,000 fpm, unless noted otherwise. Hood area (minimum) shall equal the throat area.

Exhaust Relief Hood shall be Loren Cook, Penn, Carnes, Louvers and Dampers, Inc., Greenheck, Cesco or equal.

1.20 OUTDOOR AIR INTAKE HOOD:

Furnish and install Loren Cook Model GI or equal, intake unit of the size as designated on the Drawings. Unit shall be constructed of 0.051 gauge aluminum cap and 0.080 gauge aluminum base with riveted and welded construction. Unit shall include 1/2 inch mesh aluminum bird screen and motorized damper.

Roof curb shall be provided with unit and shall be Loren Cook Model Type RCG or equal. Roof curb shall be a minimum of 8 inches above finished roof line and shall include 2 inches of thermal insulation.
Motorized damper shall be Ruskin Model RCD46, Louvers and Dampers, American Warming and Ventilating or equal.

The intake hood shall have an extended throat which shall provide 18 inches between the finished roof line and the hood intake. Extension shall be reinforced for additional height.

Hood size shall be as noted on the Drawings. Hood shall not exceed 0.10 inch w.g. pressure drop at rated capacity and intake velocity shall not exceed 500 fpm unless noted otherwise. Hood area (minimum) shall equal two times the throat area.

Intake Hoods shall be Loren Cook, Penn, Carnes, Louvers and Dampers, Inc., Greenheck, Trane, Cesco or equal.

1.21 AUTOMATIC TEMPERATURE CONTROL:

Install the automatic temperature control dampers, air flow monitoring devices, openings for air flow switches, alarms and control devices as provided by the Automatic Temperature Control Contractor.

These dampers and devices shall be installed under the direct supervision of the Section 230900, AUTOMATIC TEMPERATURE CONTROL Contractor and in strict accordance with the manufacturer's recommendations.

Caulk around all sides of high efficiency damper frames.

1.22 PACKAGED SCREW CHILLER:

Furnish and install a packaged screw chiller where shown on the Drawings.

Furnish and install a microprocessor controlled, screw compressor, air-cooled, liquid chiller of the scheduled capacities as shown and indicated on the Drawings, including but not limited to Chiller package, charge of refrigerant and oil, electrical power and control connections and chilled water connections.

Chiller shall be designed, tested, rated and certified in accordance with, and installed in compliance with applicable sections of the following Standards and Codes:

1. ANSI/ASHRAE Standard 15 – Safety Code for Mechanical Refrigeration.
2. ANSI/NFPA Standard 70 – National Electrical Code (NEC).
3. ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
4. ARI Standard 550/590 – Centrifugal and Rotary Screw Water Chilling Packages.
5. Conform to Underwriters Laboratories (UL) for construction of chillers and provide UL Listing Label.
6. Manufactured in facility registered to ISO 9002.

Chiller shall be pressure-tested, evacuated and fully charged with refrigerant and oil, and shall be factory operational run tested with water flowing through the vessel.

Manufacturer shall Warrant all equipment and material of its manufacture against defects in workmanship and material for a period of one year from date of initial start-up. The compressors shall have a five year parts and labor warranty.

Chiller shall be designed, selected and constructed using a refrigerant with flammability rating of "1", as defined by ANSI/ASHRAE Standard-34 Number Designation and Safety Classification of Refrigerants. Chiller shall include, but is not limited to: a complete system with not less than two independent refrigerant circuits, screw compressors, direct expansion type evaporator, air-cooled condenser, refrigerant, lubrication system, interconnecting wiring, safety and operating controls including capacity controller, control center, motor starting components and special features as specified herein or required for safe, automatic operation.

External structural members shall be constructed of heavy gauge, galvanized steel coated with baked on powder paint which, when subject to ASTM B117, 500 hour, 5% salt spray test, yields minimum ASTM 1654 rating of "6".

Compressors for chillers shall be scroll or screw type.

Scroll compressors shall be direct drive operating at 3600 rpm. Integral centrifugal oil pump, inlet dirt separator, rolling element bearings, crankcase heater, completely enclosed compression chamber with no leakage paths, scrolls have the ability to separate allowing liquid refrigerant and dirt to pass through without damaging the compressor. Provide suction gas cooled motor with over temperature and over current protection. Compressors shall be UL Listed.

Screw compressors shall be variable speed direct drive, screw type, including internal muffler, temperature actuated 'off-cycle' heater, rain-tight terminal box, internal discharge check, discharge and suction shut-off service valves and precision machined cast iron housing. Design working pressure of entire compressor suction to discharge, shall be 450 psig (31 bar). Compressor shall be UL listed. Motors shall be refrigerant suction gas cooled two-pole accessible hermetic compressor motors, full suction gas flow through 0.006" maximum mesh screen, with inherent internal thermal overload protection and external current overload on all three phases. Motor stators shall employ APT2000 type magnet wire. External oil separators shall have no moving or fragile parts, 450 psig design working pressure, and UL listing. Refrigerant system differential pressure shall provide oil flow through service replaceable, 0.5 micron, full flow, cartridge type oil filter internal to compressor. Compressors shall start at

minimum load position. Capacity control range shall be from 100% to 10% of chiller full load using continuous function slide valves, and without hot gas bypass. Step unloading in not acceptable. Provide microprocessor controlled, output pressure regulating capacity control valve to command compressor capacity independent of control valve input pressure and balance compressor capacity with cooling load.

Each independent refrigerant circuit shall include liquid line shutoff valve with charging port, low side pressure relief device, removable core filter-drier, solenoid valve, sight glass with moisture indicator, thermostatic expansion valves, and flexible, closed-cell foam insulated suction line.

Evaporator shall be direct expansion type with refrigerant inside high efficiency copper tubes and chilled liquid forced over the tubes by galvanized steel baffles. Independent refrigerant circuits per compressor shall be constructed, tested and stamped in accordance with applicable sections of ASME pressure vessel code for minimum 350 psig (24 bar) refrigerant side design working pressure and 150 psig (10 bar) water side design working pressure. Shell shall be covered with ¾" (19mm), flexible, closed-cell insulation, thermal conductivity of 0.26k [BTU/HR-Ft-^{o}F]in.) maximum. Water nozzles shall have grooves for mechanical couplings, and shall be insulated by the Contractor after pipe installation. Provide vent and drain fittings.

Air cooled Condenser coils shall be internally enhanced, seamless copper tubes, mechanically expanded into aluminum alloy fins with full height collars. Subcooling coil shall be an integral part of the condenser. Design working pressure shall be 450 psig (31 bar).

Fans shall be dynamically and statically balanced, direct drive, multi-speed corrosion resistant glass fiber reinforced composite blades molded into low noise, full airfoil cross section, providing vertical air discharge from extended orifices for efficiency and low sound. Each fan shall be in its own compartment to prevent cross flow during fan cycling. Guards shall be of heavy gauge, PVC (polyvinyl chloride) coated or galvanized steel. Fan motors shall be high efficiency, direct drive, 6 pole, 3 phase, insulation class "F", current protected, totally enclosed air-over (TEAO), rigid mounted, with double sealed, permanently lubricated, ball bearings.

Refrigerant economizer shall be stainless steel plate type, oven brazed with copper, UL Listed, 450 psig (31 bar) design working pressure.

Controls shall include automatic start, stop, operating and protection sequences across the range of scheduled conditions and transients. The control circuit transformer and the primary fused disconnect shall be Factory mounted having a lockable external handle and 115V/1PH secondary circuit for heat trace and controls. Microprocessor enclosure shall be rain and dust tight NEMA 3R/12 (1P55) powder painted steel cabinet with hinged, latched and gasket sealed door.

Microprocessor control center shall have:

1. Automatic control of compressor start/stop and load/unload, anti-coincidence and anti-recycle timers, automatic pump-down at start-up and shut-down, condenser fans, evaporator pump, evaporator heater, unit alarm contacts, run signal contacts, and chiller operation from 0^{o}F to 125^{o}F (-18^{o}C to 52^{o}) ambient. Automatic reset to normal chiller operation after power failure.
2. Set-point Reset:
    a. Pulse Width Modulated (PWM) input to reset current unload set-point downward via signal from external Building Automation System (BAS), maximum allowable reset

programmable from microprocessor keypad.

b. PWM input to reset the chilled liquid set-point upward via signal from remote BAS, maximum allowable reset programmable from microprocessor keypad.

3. Software stored in non-volatile memory, with programmed set-points retained in lithium battery backed real time clock (RTC) memory for minimum 5 years.
4. Forty character liquid crystal display, descriptions in English (or Spanish, French, Italian or German), numeric data in English (or Metric) units. Sealed keypad with sections for Set-points, Display, Entry, Print, Program, Clock and Unit On/Off Switch.
5. Programmable Set-points (within Manufacturer limits): display language: discharge pressure unload and cutout; low suction pressure cutout; low and high ambient cutouts; leaving chilled liquid temperature: set-point, control range, and cutout; high motor current unload; anti-recycle time; lag compressor start; local or remote control; units of measure; compressor lead/lag; power failure re-start (auto or manual), and maximum EMS-PWM reset temperature range.
6. Display Data: Chiller liquid return and leaving temperatures, ambient, lead compressor identification and lead/lag delay, clock and schedule, (variable) out of range, remote input indication, chilled liquid reset set-point, leaving liquid pull-down rate set-point, leaving liquid error (deviation from set-point), and history data for last six shutdown faults. Compressor suction, discharge, and oil pressures and temperatures, suction and discharge superheats, percent of full-load motor current, operating hours, starts and anti-recycle timer status. Status Messages for manual over-ride, unit switch off, compressor run, run permissive, remote controlled shut down, no cooling load, daily/holiday shut down, anti-recycle/anti-coincident timer, high pressure low suction temperature limit.
7. System Safeties: Shall cause individual compressor systems to perform auto-reset shut down; manual reset required after the third trip in 90 minutes. Includes: high discharge pressure or temperature, low suction pressure, high / low motor current, high pressure switch, high / low differential oil pressure, high oil temperature and motor protector. Compressor motor protector shall protect against damage due to: low or high input current, phase reversal (reverse rotation), current unbalance, phase loss, thermal overload of windings and low voltage.
8. Unit safeties: Shall be automatic reset and cause compressors to shut down if: high or low ambient, low leaving chilled liquid temperature, under voltage, and flow switch operation. Contractor shall provide flow switch and wiring per chiller manufacturer requirements.
9. Alarm Contacts: High or low ambient, low leaving chilled liquid temperature, low voltage, low battery and (per compressor circuit): high discharge pressure or temperature, low suction pressure, low or high motor current, low or high differential oil pressure, and high oil temperature.

Manufacturer shall provide any controls not listed above, necessary for automatic chiller operation. Contractor shall provide field control wiring necessary to interface sensors to the chiller control system.

Power panels shall have:

1. NEMA 3R/12 (IP55) rain/dust tight, powder painted steel cabinets with hinged, latched and gasket sealed outer doors equipped with wind struts for safer servicing. Provide main power connection(s), compressor and fan motor start contactors, current overloads and factory wiring.

2. Field power supply wiring connections shall be to a single power center on the chiller, shall be 3 phase of scheduled voltage, and shall connect to terminal blocks per each of the two motor control panels. Separate disconnecting means and/or external branch circuit protection (by Contractor) required per applicable local or national codes.

3. Provide two electrically separate, adjacent motor control center cabinets, with independent doors and separated by a steel panel, for compressor and fan motor power distribution components.

4. The chiller shall have factory mounted disconnect(s).

Exposed compressor and fan motor power wiring shall be routed through liquid tight conduit.

Power supply connections shall be a single point terminal block with individual system circuit breakers. Field provided branch circuit shall connect to single point terminal block. Factory provided interconnecting wiring to branch circuit breakers and compressor motor start components in each of two motor control center cabinets.

Protective chiller panels shall be louvered steel panels on external condenser coil faces, painted as per remainder of unit cabinet. Heavy gauge, welded wire-mesh, coated to resist corrosion shall be provided around base of machine to restrict unauthorized access.

Manufacturer shall provide separately: chiller with integral evaporator, leaving and return water sensors, and liquid line components (solenoid valves, filter driers, sight glasses, and TXV's), as discrete elements of a complete factory system. Contractor shall field erect system and provide interconnecting piping and wiring in accordance with manufacturer recommendations.

Flow Switch (Field Mounted) shall be vapor proof SPDT, NEMA 4X switch, 150 psig, -20^{o}F to 250^{o}F.

Rig and install in full accordance with manufacturers requirements, Drawings and Contract Documents. Locate chiller as indicated on Drawings, including cleaning and service maintenance clearance per manufacturer instructions. Adjust and level chiller on support structure. Installing Contractor shall provide and install all auxiliary devices and accessories for fully operational chiller. Coordinate electrical requirements and connections for all power feeds with Electrical Contractor (Division 16). Coordinate all control requirements and connections with Controls Contractor. Installing Contractor shall paint damaged and abraded factory finish with tough-up paint matching factor finish.

The chillers shall digitally interface to the Building Automation System (BAS). The chiller supplier shall be responsible to provide an interface device between each chiller and the BAS, including standardized communications protocol software for a Lon Mark or BACNET interface and data mapping tables as required by the BAS design.

The following chiller parameters shall be transferred digitally to the BAS for each chiller:

1. Enable-Disable control.
2. Chiller demand control.
3. Chilled water setpoint adjust.
4. Chilled water return temperature.

5. Chilled water supply temperature.
6. Chiller alarm.

The BAS Contractor shall be responsible to provide digital interface devices, drivers for interfacing with LonMark protocols, software indigenous to the BAS, and graphic displays for the chillers at the central BAS operator's work station.

Provide the following as required to meet scheduled sound performance data at all load points.

1. Ultra Quiet fans (Factory Mounted)
2. Compressor Sound Blankets (Factory Mounted)
3. Acoustical perimeter enclosures (Field Mounted)

SOUND PRESSURE LEVELS in dB at 30.0 (ft.) **

(Equipped with Ultra Quiet Fans, Acoustic Sound Blanket kit and Perimeter Sound Kit)

Load %	Ambient (°F)	63	125	250	500	1K	2K	4K	8K	dBA
100.0	95.0	-	-	-	-	-	-	-	-	67
75.0	80.0	-	-	-	-	-	-	-	-	64
50.0	65.0	-	-	-	-	-	-	-	-	61
25.0	55.0	-	-	-	-	-	-	-	-	60

** Chiller is assumed to be a point source on a reflecting (hemispherical radiation)

Screw Chiller shall be York, McQuay, Trane, Carrier or equal.

1.23 FAN-POWERED VAV TERMINALS (DDC):

Furnish and install series fan powered variable air volume terminals of sizes and capacities as shown on the Drawings.

At maximum cooling the terminal shall supply all primary air. At minimum cooling the primary air cfm shall be 30 percent of design cfm unless designated otherwise in the schedule on the Drawings.
All performance shall be ARI certified.

Damper leakage shall be less than 1 percent of maximum cfm at 3 inches static pressure.

The terminal manufacturer shall provide a flow cross or two (2) pipe sensor suitable for interfacing with a differential pressure transducer. The flow sensor shall include auxiliary taps for use by the Balancing Contractor. The transducer shall be supplied by the temperature control contractor.

Fans shall be forward curved with direct drive, 4-speed or variable speed, permanently lubricated split capacitor type motors with either integral motor overload protection and disconnect switch

or a manual motor starter with thermal overloads, with solid neutral bus and number of poles required for connected voltage. Fans shall be dynamically balanced and mounted on rubber vibration isolators. Dampers shall be provided on the terminal discharge to prevent fan motor overloading.

The casing shall be constructed of coated steel meeting SMACNA or ASHRAE Standards. Internal insulation shall meet the requirements of NFPA Bulletin 90A and UL 181.

Heating coils where required shall be factory mounted and sized as shown in the schedule on the Drawings. Coils shall be designed for hot water. Coils shall be single tube seamless copper 5/8 inch OD. Tubes and U-bends shall be combined in a single tube using silver brazing. Supply and return connections shall be 3/4 inch internal threaded. Casings shall be constructed of heavy galvanized steel and shall have 12 inch long by 6 inch wide access panels on the inlet of the heating coil. The access panels shall be gasketed and screwed to the bottom of the heating coil section. Bronze, spring type turbulators shall be furnished, if required to meet capacities needed where water velocities are 4 feet per second or less. Coils shall be tested at 250 psi air pressure under water.

Fan-powered VAV Terminals shall be Carnes, Enviro-Tec, Krueger, Nailor, Price, Titus, Trane, Tuttle and Bailey, York or equal.

1.24 VAV/REHEAT TERMINALS (DDC):

Furnish and install variable air volume terminals and reheat terminals of sizes and capacities as shown on the Drawings.

At minimum cooling the VAV terminal shall be 30 percent of design cfm unless designated otherwise in the schedule on the Drawings.

All performance shall be ARI certified.

The terminal manufacturer shall provide a flow cross or two (2) pipe sensor suitable for interfacing with a differential pressure transducer. The flow sensor shall include auxiliary taps for use by the Balancing Contractor. The transducer shall be supplied by the temperature control contractor.

The casing shall be constructed of coated steel meeting SMACNA or ASHRAE Standards. Internal insulation shall meet the requirements of NFPA Bulletin 90A.

Heating coils where required shall be factory mounted and sized as shown in the schedule on the Drawings. Coils shall be designed for hot water. Coils shall be single tube seamless copper 5/8 inch OD. Tubes and U-bends shall be combined in a single tube using silver brazing. Supply and return connections shall be 3/4 inch internal threaded. Casings shall be constructed of heavy galvanized steel and shall have 12 inch long by 6 inch wide access panels on the inlet of the heating coil. The access panels shall be gasketed and screwed to the bottom of the heating coil section. Bronze, spring type turbulators shall be furnished, if required to meet capacities needed where water velocities are 4 feet per second or less. Coils shall be tested at 250 psi air pressure under water.

VAV Terminals shall be Carnes, Enviro-Tec, Krueger, Nailor, Price, Titus, Trane, Tuttle and Bailey, York or equal.

1.25 ROOF CURBS:

Prefabricated insulated metal roof curbs shall be Custom Curb Model CRC-3 or equal.

Prefabricated metal roof curbs shall be used at all roof penetrations including but not limited to HVAC units, duct openings, and pipe penetrations.

Curbs shall be constructed using minimum 18 gauge galvanized steel, 14 gauge for curbs supporting HVAC units, or as deemed necessary by curb manufacturer, with fully mitered and welded corners, integral base plates, internally reinforced with 1" x 1" x 1/8" steel angle, factory insulated with 1-1/2" thick three pound density fiberglass insulation and factory installed pressure treated wood nailers.
Minimum height of curb shall be 8" above finished roof or as specified.

Curbs shall be constructed to match slope of roof and provide a level top surface for mounting of mechanical equipment. Where curb caps are required the top of curb shall be constructed of a minimum two layers of 3/4" plywood with a minimum 18 gauge galvanized steel curb cap. Curb shall be infilled with insulation equal to the roof insulation.

Curbs shall be installed in strict accordance with manufacturer’s printed instructions and as detailed on the Drawings.

Roof Curbs shall be Custom Curb, Kees, Pate, Thy Curb, Roof Product Systems or equal.

1.26 EQUIPMENT SUPPORTS:

Prefabricated metal equipment supports shall be Custom Curb Model CES-3 or equal.

Equipment supports shall be constructed using minimum 18 gauge galvanized steel, fully mitered and welded corners, internal bulkhead reinforcing, integral base plates, 2 x 4 factory installed pressure treated wood nailer and 18 gauge counterflashing.

Minimum height of support shall be 8" above finished roof or as specified sloped to match slope of roof.

Equipment supports shall span a minimum of two structural members. No load shall be applied to a cantilever exceeding 1'-0" in length. Equipment supports shall be installed in strict accordance with manufacturer’s printed instructions and as detailed on the Drawings.

Equipment Supports shall be Custom Curb, Kees, Pate, Thy Curb, Roof Product Systems or equal.

1.27 KITCHEN HOOD:

Furnish and install a Greenheck Model No. GHEW or equal kitchen hood where shown on the Drawings.

All exposed areas shall be fabricated of stainless steel, type 304 with #3 polish finish. Minimum thickness shall be 18 gauge. Unexposed areas shall be fabricated of galvanized steel, 18 gauge minimum thickness.

All joints and seams shall be heliarc welded liquid tight, ground and polished to match original finish of metal.

Hood lights shall be 277 volt U.L. Listed for commercial cooking hood use, fluorescent vapor proof, greaseproof, heatproof and waterproof construction. Provide four 4 foot fixtures, 2 per side pre-wired to a control panel located on end of hood.

Grease extractors shall be Underwriters Laboratories Classified, stainless steel construction with flame barrier protection, self balancing, self draining and easily removable for cleaning.

The hood shall be equipped with multi-cyclone stainless steel grease extractors. The grease extraction efficiency shall be a minimum of 93% on particles with a damper of 5 microns and 98% on particles with a diameter of 15 microns or larger, as tested by an independent testing laboratory. The pressure loss over the extractor shall not exceed 0.50" of water at flow rates approved by U.L. for heavy load cooking. Sound levels shall not exceed an NC rating of 55. Baffle or slot type extractors shall not be used.

Grease shall drain from an integral grease trough to a removable and easily cleanable pull out container located out of the air stream.

Hood shall be fabricated to meet or exceed the requirements of the current edition of NFPA Bulletin 96. It shall conform to the requirements of the National Sanitation Foundation and bear its seal. All electrical wiring shall meet the standards of the National Electrical Code 70.

A wet chemical, ANSUL R102, fire suppression system shall be provided by the hood manufacturer. This system shall be complete and include factory pre-piping of hood, nozzle installation, chemical tank, chemical agent, detectors, fusible links, remote pull station, micro switch contacts, complete final hook-up in field by authorized ANSUL dealer contracted by hood manufacturer. An electric gas shut-off valve shall be provided by the hood manufacturer. Gas valve installation will be the responsibility of the Contractor. The chemical tank shall be mounted in the kitchen hood end control cabinet.

Wall Canopy Kitchen Hood shall be Greenheck, Halton or equal.

1.28 TESTS:

General:

The Contractor shall furnish a competent individual familiar with the installation to assist the Balancing Company and make the necessary mechanical equipment adjustment as directed by the Balancing Company. The Contractor shall also furnish the necessary ladders, scaffolding, etc., needed for access to test and balance all systems.

The Contractor shall provide replacement pulleys, etc. as required to properly balance the ventilation equipment.

The following tests shall be performed on the respective systems. Tests shall be repeated until each system is proven acceptable.

Heating and Cooling:

The Contractor shall employ an independent testing and balancing company to properly balance the water flow to and from all coils and equipment and make any adjustments necessary in balance valves, etc., to meet the required flows.

The Contractor shall furnish to the Architect/Engineer three (3) typewritten copies of tabulations of the water flows. This tabulation shall include unit number, room number, gpm for all connections, showing both design gpm and actual gpm. The Contractor shall tabulate all pump pressure differentials, gpm and pump motor current and voltage readings taken after all terminals and equipment have been balanced. List the bypass gpm on 3-way valves. The Contractor shall operate the controls (thermostat, etc.) to verify that the gpm changes from no flow to design flow and shall designate the results in the report.

Ventilation and Air Conditioning:

The Contractor shall make thorough tests of the following systems.

Air Systems:

The Contractor shall make a thorough test of all air systems. He shall employ an independent testing and balancing company to properly balance the air flow to and from all openings and make any adjustments necessary in fan speeds, etc., to meet the required air volume.

The Contractor shall furnish to the Architect/Engineer three (3) typewritten copies of tabulations of the air volumes. This tabulation shall include unit number, room number, supply, return, or exhaust CFM's for all openings, showing both required CFM and calculated CFM, grille size, minimum cooling VAV terminal CFM, heating VAV terminal CFM and maximum VAV terminal CFM. The Contractor shall also submit a tabulation of all fan RPM's, static pressure, CFM's and fan motor current and voltage readings taken after the terminals have been balanced.

Independent Testing and Balancing Company:

Testing and balancing work shall be executed under the direct supervision of a registered professional engineer having an experience record of not less than five (5) years in the mechanical contracting industry, engaged in testing, balancing and adjusting of air and hydronic mechanical systems for not less than two (2) years of that time; or, under the direct supervision of a qualified testing, adjusting and balancing supervisor, possessing certification from the National Environmental Balancing Bureau (NEBB). Testing and balancing work shall not be done by the installing contractor.

Comply with the applicable procedures in the chapter on Testing, Adjusting and Balancing in the latest ASHRAE Edition of the Systems Handbook.

Calibration and maintenance of instruments shall be in accordance with manufacturer's standards and recommendations, and calibration histories for each instrument shall be available for examination.

Accuracy of measurements shall be in accordance with the applicable measurement means as listed in the chapter on Measurement and Instruments in the latest edition of ASHRAE Fundamentals Handbook.

Allowable Tolerances:

Tolerances of adjustment for air handling systems are plus or minus 5% for supply systems and plus or minus 10% for return and exhaust systems from figures shown on the Drawings.

Tolerances of adjustment for hydronic systems, are plus or minus 10% of design conditions shown on the Drawings.

Rebalancing and adjustments found necessary to maintain and to achieve satisfactory operating conditions during the contract guarantee period shall be performed by the Testing and Balancing Subcontractor.

Acceptable Testing and Balancing Companies meeting the above requirements are as follows:

Balancing Professionals, Inc.
Johnson Controls, Inc.
Precision Test and Balance
ReCom, Inc.
Systems Management and Balancing, Inc.
Tab, Inc.

Independent testing and balancing companies not listed above must submit for approval prior to the Bid.

END OF SECTION 230800

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SECTION 230900 - AUTOMATIC TEMPERATURE CONTROL/BUILDING AUTOMATION SYSTEM

1.01 SCOPE:

The GENERAL, SUPPLEMENTAL and other CONDITIONS of the Contract and the GENERAL REQUIREMENTS (Division 1) are hereby made part of this Section.

Section 230100, General Provisions, in its entirety, including references to the General Construction Specifications, are hereby adopted and made part of these Specifications

The work involved in this specification and the accompanying drawings consists of performing all labor and furnishing of all materials, fixtures and equipment necessary to install complete automatic temperature control systems, as described herein and/or shown on the Drawings. This includes all piping, wiring and materials obviously necessary for complete systems though not specifically mentioned or shown.

Furnish and install an Automatic Temperature Control/Building Automation System (ATC/BAS) as manufactured by Siemens, Johnson or Honeywell.

The ATC/BAS shall be installed by the manufacturer's trained personnel. The Contractor shall be a Factory Authorized Distributor or Branch Office certified to engineer, install and service the brand of temperature control equipment specified herein. The Contractor shall have represented the brand of control equipment for the proposed installation for a minimum period of 5 years. Installation by mechanical contractors will not be allowed.

ATC/BAS components shall be the manufacturer’s latest standard design that complies with the specification requirements and in conformance with the following applicable standards for products specified:

A. American Society for testing and materials, ASTM
B. Institute of Electrical and Electronic Engineers, IEEE
C. National Electrical Manufacturers Association, NEMA
D. Underwriters Laboratory, UL (UL 916)
E. FCC Regulation, Part 15, Section 156
F. National Fire Protection Association, NFPA
G. Local building codes

1.02 WORKMANSHIP:

Installation workmanship must be the highest quality.

Panels must be amply sized to allow all components to be permanently mounted with ample space for wiring between components and around the panel perimeter. Groups and bundles of control wiring shall be in a gutter system with a removable cover.

Control wiring shall be cut with spare length at both ends to allow for connections at both ends with ample wire length and no splices adjacent to the connection. Control wiring shall not be spliced inside control panels. All wiring shall terminate on labeled terminal blocks or device

mounted terminals under screws. All wires terminating under a common screw should be the same wire gauge or diameter.

All components must be permanently fastened inside control panels. Components shall be permanently labeled for the systems they serve and their function.

Control wiring must be routed parallel along and perpendicular to structural members.

Control wiring must be routed utilizing the cable tray system where cable tray systems are available.

Control wiring shall be installed in conduit in exposed locations, i.e., Mechanical Rooms and areas with exposed structure (no ceiling). Final connections to control components (valve actuators, damper actuators, etc.) must be by flexible conduit from a J-box set adjacent to the control component.
Control conduit ends must have insulated throats.

1.03 SUBMITTALS:

The ATC/BAS Contractor shall provide an equipment submittal that includes manufacturers' catalog data describing each item of control equipment or component to be provided and installed on the project.

The Contractor shall submit CAD generated schematic drawings for the entire control system for review and approval before beginning installation of the control system. Included in the submittal drawings shall be a one page diagram depicting the system architecture complete with a communications riser. Drawings shall include point-to-point wiring diagrams and must show: all controls, start-stop arrangement for each piece of equipment, equipment interlocks, wiring terminal numbers and any special connection information required for properly controlling the mechanical equipment. The submittal shall include a bill of material reference list as well as equipment sequences of operation.

The Contractor shall submit all software logic flowcharts and graphics for the control system for review and approval before programming shall begin.

1.04 PROTECTION OF SOFTWARE RIGHTS:

Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:

A. Limiting use of software to equipment provided under these specifications.
B. Limiting copying.
C. Preserving confidentiality.
D. Prohibiting transfer to a third party.

1.05 ELECTRICAL INSTALLATION:

The ATC/BAS Manufacturer shall be responsible for installation of all of the control wiring to provide for a complete operating system. This electrical wiring shall include but not be limited to the following:

A. The term "control wiring" is defined to include the providing of wire, conduit, and miscellaneous materials as required for the mounting and connecting of electric or electronic control devices.

   Control wiring includes but is not limited to the line and low voltage communications and power wiring necessary for the proper operation of the DDC controllers as described herein. Control wiring shall be grouped and tied together along building lines parallel with and perpendicular to structural members. Control wiring shall be routed in the cable tray system when such a system is provided by Division 26 - Electrical.

B. All exposed wiring, low and line voltage, shall be run in conduit. Line and low voltage wiring shall be run in separate conduits. Concealed but accessible wiring, except in mechanical rooms and areas where other conduit and piping are exposed shall run in UL plenum rated cable as approved by local codes unless expressly restricted by requirements in the Division 16 specification. Plenum cable shall be installed high enough to provide adequate clearance for ceiling tile removal.

C. All power wiring shall be run by the Contractor from circuit breakers provided by the Division 26 electrician to the respective DDC controller (s). This includes the terminal box ASC controllers provided under this section of the specifications.

D. All wiring shall be installed in accordance with local and national codes as defined in the Division 26 specifications.

E. Numbered or color-coded conductors shall be used to allow for future identification and servicing of the control system.

F. All wall mounted sensors/thermostats shall be roughed in using a standard electrical box with conduit in the wall extended to the accessible ceiling area. They shall be mounted in accordance with and at a height to comply with The American's With Disabilities Act (ADA), unless noted otherwise on the Drawings. Mounting sensors with anchors or toggle bolts is not permitted.

1.06 INSTALLATION OF CONTROL VALVES, DAMPERS AND DEVICES:

All automatic control valves, water monitoring devices, flow switches, alarms and control devices shall be furnished by the ATC/BAS supplier and installed under his direct supervision by the Division 22 Contractor as noted in Section 220600 - HEATING.

All automatic control dampers, air flow monitoring devices, flow switches, alarms and control devices shall be furnished by the ATC supplier and installed under his supervision by the Mechanical Contractor as noted in Section 230800 – VENTILATION AND AIR CONDITIONING.

Furnish and install all switches, relays, contactors, etc. required for a complete operating system as specified in the Sequence of Operation.

1.07 FREEZE PROTECTION:

Furnish and install a manual reset freeze protection thermostat on the discharge of each heating coil of

each system with a fresh air connection which will shut off the fan motor, fully close the fresh air damper and open the coil valves to full flow whenever the coil outlet air temperature falls below its setting. This device shall be hard wired to the motor starter/contactor.

1.08 PACKAGED UNIT REMOTE CONTROL PANELS:

Remote control panels furnished by the heating ventilation and air conditioning equipment manufacturers shall be wired and tested by this Contractor. Remote control panels furnished by the heating ventilation and air conditioning manufacturers shall be mounted respectively under Section 22600 and Section 23800 of these Specifications

1.09 PRODUCTS:

Temperature Sensors:

Temperature sensors shall be linear precision elements with ranges appropriate for application, accurate within 1°F over normal operating range.

A. Space sensors shall be available with concealed setpoint adjustment and override switch. Space sensor shall have a portable service tool jack. Setpoint adjustment shall be capable of being overridden through software. Provide metal sensor guards where shown on the Drawings.

B. Duct mounted averaging sensors shall utilize a sensing element incorporated in a copper capillary with a minimum length of 20 feet. The sensor shall be installed according to manufactures recommendation and looped and fastened at a minimum of every 36 inches and changes in direction.

C. Sunshields shall be provided for outside air sensors.

D. Thermowells for all immersion sensors shall be stainless steel or brass as required for application.

Humidity Sensors:

Humidity sensors shall have a range of 0% to 100% with an accuracy of +/-3%.

Air Velocity Sensors:

The sensor shall have a repeatability within 1% of reading and an accuracy of +/-5% of range.

Differential Pressure Sensor:

The differential pressure sensor shall have an accuracy of +/-2% of range.

Carbon Dioxide/Volatile Organic Compound Sensor:

Staefa Model QPA63.2 or equal sensor shall be able to monitor both carbon dioxide and Volatile Organic Compound (VOC) concentrations. Sensor shall measure CO2 over a range of 0 – 2000 PPM with an accuracy of +/- 5% full scale. Sensor shall require no maintenance. Ventilation demand

calculator shall compare the two demand signals (CO2 and VOC) and output the greater of the two as the common indoor air quality demand signal. LED indication of air quality shall be provided. Staefa Model ARG64 duct mounting kit shall be used if measurement in duct is specified.

Occupancy Sensor:

Occupancy sensor shall be of the passive infrared or ultrasonic receiver type. As a minimum the occupancy sensor shall provide adjustments for timed-on delay and sensor sensitivity.
Terminal Unit Velocity Sensors:

Sensor shall have an installed accuracy of +/-5% of range and repeatability of +/-25 FPM.

Low Temperature Protection Thermostats:

Shall be the manual reset type. The thermostat shall operate in response to the coldest one foot length of the 20-foot sensing element, regardless of the temperatures at other parts of the element. The element shall be properly supported to cover the entire downstream side of the coil with a minimum of three loops. Separate thermostats shall be provided for each 25 square feet of coil face area or fraction thereof. The thermostat shall be adjustable down to 15°F.

Differential Pressure Switches:

Pressure differential switches shall have SPDT change-over contact, switching at an adjustable differential pressure setpoint. Repeatability shall be better then +/-.02" H_2O.

Current Sensing Relays:

Current sensing relays shall have setpoint adjust, trip indication and five year unconditional warranty.

Flow Switches:

Flow switches shall be of the paddle type equipped with SPDT contacts to establish proof of flow. Flow switches shall be of the vapor-proof type.

Electric Thermostats:

Thermostats shall have SPDT contacts with a concealed setpoint adjustment from 55 to 85°F. Provide metal thermostat guards where shown on the Drawings.

Control Valves:

Valves shall be selected to meet the individual systems design pressure, temperature and medium. Valves on equipment with outside air capability shall fail open unless noted otherwise. Convertor valves and boiler isolation valves shall fail closed. Two way valves of 440 CV or less, and three way valves of 91 CV or less, shall be industrial quality ball valves with Belimo actuators as assembled by Delta Control Products or equal. Valves assemblies shall have a minimum resolution of 250 to 1 and be rated for 250 psi working pressure and 450 F working temperature. Water valves shall be sized for a 2 psi pressure drop except where noted otherwise and low pressure steam valves (< 15 psi) shall be sized for 80% pressure drop of inlet pressure. Valves 2 1/2 inches and larger shall be flanged with a turndown ratio of 40 to 1. Butterfly valves shall be as assembled by Delta Control Products or equal.

Terminal Unit Fan Speed Controllers:

Fan speed controller shall be capable of controlling the speed of single phase terminal fan motors with power factors of between 0.7 and .95 inductive and operating amperage less than 5 amps. The fan speed controller shall be rated for 120 VAC or 277 VAC. The fan speed controller shall bear a UL508 listing.

Control Dampers:

Automatic control dampers shall be Ruskin Model No. RCD46/CD356 or equal and have 16 gauge galvanized steel blades with integral structural reinforcing running full length of the blade. The frame shall consist of 16 gauge galvanized steel. There shall be no blade over 8 inches in width, 48 inches in length, without support, and all damper bearings shall be synthetic type. Blade edge seals shall be EPDM rubber or PVC coated polyester fabric suitable for -25^{o}F to 180^{o}F mechanically locked into the blade edge and jamb seals shall be of the flexible metal compression type. Dampers shall be AMCA certified for leakage not greater than 6 cfm per square foot at a 4 inch w.g. pressure differential (24 inch wide). Modulating dampers shall be opposed blade.

Round control dampers shall be of the butterfly type consisting of a circular blade mounted to a shaft. Inside frame surface shall be clean and smooth with no blade stops or similar inward projections. Frames shall include rolled stiffener beads to allow easy sealing of spiral ductwork joints. Dampers shall include a firm, closed-cell neoprene seal sandwiched between two blades. Leakage through the damper in the closed position shall not exceed 0.15 scfm per inch of blade circumference at a pressure differential of 4" w.g. Leakage through the bearings shall be less than 0.25 cfm at 4" static pressure. Damper frame and blade shall be fabricated from galvanized steel. All parts not protected shall be given one coat of aluminum paint.

All automatic control dampers shall be furnished by the ATC supplier and installed under his supervision by the Contractor as noted in Section 230800.

Damper Actuators:

Damper actuators shall be Belimo or equal. Actuators shall be built for modulating operation with ample power for the service required. All AHU damper actuators and outside air damper actuators shall be spring return unless noted otherwise..

VAV/Reheat Terminal Actuators:

Actuators shall be of the rotary type capable of permanent stall operation without damage. The actuator shall also have adjustable stop for stroke limit. Actuators shall utilize metal housing with nickel steel gears, oil impregnated for lifetime operation, and fit directly over the damper shaft.

Local Controls Panels:

All relays, switches, transducers and other field interface devices, for equipment located within the mechanical equipment rooms, shall be panel mounted. All electrical devices within the panels shall be wired to a numbered terminal strip. All wiring within the panel shall be run in accordance with NEMA and UL standards, and shall meet all local codes. Panels shall be NEMA type suitable for

applications as required. Each panel shall have a final as-built control drawing, reduced, laminated and mounted inside of the panel door.

Control Labels:

All temperature control devices in the Mechanical Rooms shall be provided with plastic laminate nameplates indicating their purpose in operation fastened with screws or rivots. Embossed/printed tape labels are not acceptable. This shall include all thermometers, switches, gauges, etc., mounted in the face of the control panels, all control devices mounted inside the control panels, and all miscellaneous control devices mounted remote from the control panels.

Each control panel shall be properly identified to indicate the system or systems which it serves. The corresponding equipment shall also be similarly identified.

Thermostat/Sensor Guards:

Where shown on the Drawings or in vestibules, corridors, toilet rooms or other unsupervised areas, provide sturdy (wire or cast aluminum) thermostat guards. Provide guards with a substantial base plate securely anchored to the wall. Thermostat/sensor access shall be by tamperproof screws or keyed lock. Recessed sensors with flush wall cover plate (flat plate) sensors may be provided in lieu of sensor guards.

Miscellaneous:

The ATC/BAS Contractor shall furnish all electric relays. All electric control devices shall be of a type to meet current, voltage, and switching requirement of their particular application. Relays shall be provided with 24 VAC coils and contacts shall be rated at 10 amps minimum.

1.10 APPLICATION SPECIFIC CONTROLLER (ASC) HARDWARE :

General:

The Application Specific Controller(s) (ASC) shall be a stand-alone controller. The controller shall include all hardware and software required for communications with the BAS. An ASC shall be dedicated for each zone terminal device (VAV). The ASC is to be mounted remotely from the room sensor.

Programs:

The control program shall reside in the ASC. The application program shall be maintained in ROM. The default database, i.e., setpoints and configuration information, shall be stored in EEPROM, or minimum of 72-hour battery backup shall be provided.

Stand-Alone:

Controllers requiring the application or database to be downloaded from a host or share processing with a "master controller" shall not be acceptable. After a power failure the ASC must run the control application using the current setpoints and configuration.

Communications:

Communication shall be at a minimum of 2400 baud.

Input:

All inputs shall be provided with a calibrate function to eliminate sensing errors.

Output:

Digital output pairs controlling a tri-state motor/transducer or pulse width modulation shall not be utilized for analog control without a matching analog position feedback input.

1.11 APPLICATION SPECIFIC CONTROLLER (ASC) SOFTWARE :

ASC shall have the following minimum capabilities:

A. DDC Control
B. Heating/Cooling Setpoint
C. Occupied & Unoccupied Setpoint Pairs
D. Terminal and Perimeter Hydronic or Electric Heat Control
E. Off-Hours Tenant Override
F. Auto-Calibrate
G. Remote Setpoint Adjust
H. Standby Mode

ASC VAV shall have the following additional capabilities:

A. Dual Minimum, Maximum and Accessory Volume Control

1.12 DIRECT DIGITAL CONTROLLER (DDC) HARDWARE:

General:

The Direct Digital Controllers (DDC) shall be a local control loop microprocessor-based controller installed at each mechanical system; (i.e., air handling units, heating plants, chiller plants, etc.). It shall be acceptable to control more than one system from a DDC as long as there are 25% spare inputs and outputs. Each DDC shall execute local control sequences, independent of a network controller or workstation. All DDC's shall be able to share analog and digital values. All control software and time programs shall be stored in EEPROM or other non-volatile field reprogrammable memory. Controllers with volatile memory shall have a battery for 72 hour database backup. Each controller shall be individually addressable by a system workstation or a portable service tool.

A. The controller network shall be able to handle up to 16 controllers. The controller network shall be true "peer to peer" communication and shall not experience degradation of communication even if any number of controllers go off line due to power loss for example.

B. The controller network shall be able to communicate at a minimum rate of 9600 baud.

C. The controller network shall be able to extend up to 7800 feet, hardwired, without any communication degradation.

D. The controller network distance shall be able to be extended by using fiber optics or RS232 line drivers.

E. Each controller shall be able to control independently.

F. Controller wiring can be daisy-chained or star configuration connected while allowing the controller network to communicate independently if one controller is disconnected or losses power.

G. Each controller shall have at minimum a 12-bit processor.

H. Each DDC shall have a local communication connector through which a portable computer can be interfaced. The controller shall not have to be removed from the network system in order for this local communication to take place.

Database:

All DDC database shall be entered, changed or downloaded to the general application controllers via a portable service workstation or system workstation.

Input/Output Modules:

Provide the following input/output capabilities:

A. Provide analog inputs which can accept industry standard analog signals such as 4-20 mA, 0-5 VDC, and 0-10 VDC.

B. Provide digital inputs which accept binary contact closures.

C. Digital outputs may be latched or momentary contact type. Digital output pairs controlling a tri-state motor/transducer or pulse width modulation shall not be utilized for analog control without a matching analog position feedback input.

D. Analog outputs shall have a .5% resolution over total output span to 100%.

E. Controller hardware shall be flexible to handle I/O expansions by hardware additions or by being able to download existing control logic into a higher density controller.

F. The analog-digital and the digital-analog conversion shall be accomplished with 12-bit resolution as a minimum.

G. Optional hand/off/auto switches and LED status indication can be provided for inputs and outputs.

Operating Environment:

The DDC shall be capable of operating in an environment of 32 to 122 ˚F and 10 to 90% relative humidity non-condensing.

Power Loss/Restart:

The DDC shall be tolerant of power failures. When a power failure has occurred and power (normal or emergency) is restored, the BAS shall execute these restart procedures, automatically and without operator intervention:

A. Come on line.
B. Update all monitored functions.
C. Implement special building start-up strategies as required.
D. Resume operation based on current time and status.

Peripheral Interface:

BAS shall be able to operate the following peripherals simultaneously.

A. Local on-line System Workstation
B. Dial-in remote System Workstation(s)
C. Local on-line reports and alarm printer
D. Remote dial-out alarm printer

Data integrity:

Data integrity shall be maintained by using cyclic redundancy checking (CRC). In the event of a CRC mismatch, communication shall be automatically retransmitted up to three times. If CRC mismatch continues for three attempts, the failure shall be audibly and visually annunciated on a System Workstation.

1.13 DIRECT DIGITAL CONTROLLER (DDC) SOFTWARE:

General:

Provide complete DDC software to execute all mechanical system local loop controls functions. Each controller type/model shall have the same software functions available. The programming software shall be able to bundle software logic (macroing) to simplify control sequencing. The software shall have the ability to have a clear indication of the control operating mode. All inputs, outputs, output override, setpoints, parameters and calculated values shall have three levels of operator security.

Control Parameters:

The software in the DDC shall produce all of the necessary reverse acting or direct acting, PID signals as required by the control sequence. The proportional integral and derivative values which make up the PID output value shall be readable and modifiable at a workstation or portable service workstation.

Networking:

Each input, output, or calculation result shall be capable of being shared with another controller on the network and able to pass these values to a higher level system network if necessary.
Control Functions:

Each DDC shall execute local control sequences, independent of a workstation. Control functions shall include but not be limited to the following:

A. Selection of minimum/maximum values
B. Serial Load Staging
C. Binary Load Staging
D. Analog Load Staging
E. Master-Submaster Routines
F. Anti-Windup for Integrated Loops
G. Enthalpy control
H. Energy recovery logic
I. Safety output interlock logic
J. Hysteresis logic to absorb minor instabilities reducing unnecessary output changes.
K. Time or Event Based Scheduling
L. Adaptive Optimum Start/Stop
M. Chiller and Boiler Reset/Optimization
N. Demand Limiting/Load Shedding
O. Tenant/Cost Center Billing
P. Hot Water/Outdoor Air Reset
Q. Run Time Totalization
R. Alarm Detection and Dial Out
S. Night Setback
T. Historical Trending
U. Indoor Air Quality, Demand Ventilation

Alarms:

The DDC shall be capable of comparing analog and digital readings to predetermined high and low limits and enunciate each time a value enters or returns from an alarm condition. The system shall be capable of suppressing selected alarm reporting when the primary equipment from which the alarm point is based in the inactive state. The alarm features of the BAS software shall, as a minimum, provide the following:

A. Digital, Analog, and Hi/Low settings and deadband
B. Sliding Alarm Limits
C. Conditional Alarming
D. Alarm inhibiting through feedback loop
E. Fluttering Alarm Suppression
F. Separate Tailored Alarm Messages of no less than 70 characters each
G. Auto-dial of any alarm condition to a minimum of 10 telephone numbers with a voice message.

Communication Diagnostics:

The DDC software shall be capable of self-diagnosing failure automatically without a query by the operator. In the event of communications failure or limited power failure, the system shall be capable of both notifying a local operator of the specific occurrence, as well as auto dialing the condition to a remote site. Auto-dial out shall be configurable to repeat the alarm while the situation remains unattended and unacknowledged. In addition to automatic self-diagnostics, communication statistics for the ASC's and DDC's communication shall be maintained. These statistics shall tabulate total

communications attempted versus successful and unsuccessful communications by unit number. The option to reset communication statistics to zero (0) at any time shall be provided.

Trending:

The ATC/BAS shall have the capability to pre-assign trend requirements for all analog or calculated or digital points in the system. Adjustable sampling intervals for each trend, from 1 second to 24 hours, shall be provided. ATC/BAS shall have the capability to simultaneously trend a minimum of 500 combined analog, calculated and digital points. All sampled trend data shall contain an indication(s) of when the data is not valid, whether from sensing or communication disruptions or other causes. Each trend shall be capable of being automatically started or stopped, based on time of day, externally sensed points, alarms, or a calculated value. Printout or upload of trend data to the System Workstation shall be operator-selectable to automatically occur at any time during the sampling period. The software shall allow analog and digital values and calculations to be graphically plotted in real-time or historical format. Uploaded trend data shall be fully compatible with MS-Excel, Lotus 1-2-3, MS-Access.

Control Logic Verification:

The control logic software shall have built-in logic that can be activated on demand to verify logic with digital and analog setpoints that can simulate actual operating conditions.

1.14 DDC OPERATOR TERMINAL/SERVICE TOOL:

Provide with the ATC/BAS the hardware and software necessary to allow commissioning, adjustment, and diagnosis of the ASC's, and DDC's. All programming shall utilize English language descriptors. A handheld service tool or laptop computer with software shall be provided.

1.15 REMOTE INTERFACE:

A remote operator shall be able to perform all control functions and all data base generation and modification functions as described for local work station. ATC/BAS shall have ability to automatically place calls to provide remote alarm indication.

1.16 SYSTEM WORKSTATION HARDWARE:

The system shall be Web based and shall be connected to the District Intranet and shall be accessible through any PC on the system via the proper ID and password.

1.17 SYSTEM WORKSTATION SOFTWARE:

Operating System:

The operating system shall be based on Microsoft Windows. The ATC/BAS shall be capable of communicating with other systems using BACnet or LONTALK protocol through a software interface or gateway. All software shall be Web based compatible.

Operators:

Multiple System Workstation operators shall be able to access the system simultaneously. Systems

which do not provide multi-tasking, multi-user operating systems are not acceptable.

Graphical User Interface:

Provide a color graphics editor which shall allow the user to generate custom dynamic graphics for graphical representation of system design and system parameters. The graphics editor shall allow zones of the building mechanical systems, floor plans, etc., to be custom generated for the project.

Graphics Creation:

The editing menu shall provide help menus for selecting graphics, choosing colors, copying previous graphics, and selecting data points. A set of standard HVAC symbols shall be provided to allow operators to select from the graphics library for graphic generation.

Display:

Information on the color graphic display shall be dynamic and automatically updated. Dynamic field data, such as analog values and equipment status' shall be displayed on graphics within 1 second of the time the field data is received by the System Workstation.

Decluttering:

The same graphic shall appear in simplified form to a non-sophisticated operator through the use of display suppression called "Decluttering". Decluttering shall allow graphics to be displayed to meet the needs of different operators with different levels of expertise. The level of display sophistication shall be automatic upon entry of the user's password. All graphic symbols, equipment, lines, etc., shall be assignable to classification groups. Displays shall be capable of being decluttered by individual or multiple classification groups by the operator.

Custom User Symbol Library:

A library of ASHRAE, ISA and logic symbols shall be provided to build the graphics database. It shall be possible to group any collection of symbols so that they may be copied and used repetitively as a group.

The ATC/BAS Contractor shall create and include a graphic diagram for each equipment item included on this project.

Reference Card:

A user reference card shall be provided. The user reference card shall allow the user to create multiple lines of site/system/equipment - specific text information. The reference card shall be invocable by an operator at any time and at any menu option. When invoked, the reference card shall appear on the System Workstation and display specific reference, explanatory, instructional or other information for the current time and menu option position.

Manual Control:

A manual control menu shall be provided, which will allow the operator to turn points on or off, adjust values of control loops, set points to local mode or release points to automatic mode.

Alarms:

Alarm directives shall be provided around the border of the graphic display so as not to impact the display information. The border display shall change color upon the occurrence of an alarm condition. The ATC/BAS shall also have the capability: to display alarm directives in popup windows on workstations, store them on disk, direct them to printers and re-route them based on time of day, day of week, etc. throughout the ATC/BAS network and to different receivers though phonelines and jump to alarm display on graphic. Alarms shall be routed to a workstation based on a combination of alarm priority and alarm class. A minimum of eight alarm priorities shall be available. Alarm classes shall be determined by the user such as HVAC, fire, security, etc. The System Workstation software shall be capability of defining up to 100 alarm classes on the system. Each alarm may be routed to workstation screen, disk file, printer or any combination thereof. The alarm message shall contain appropriate information such as date or value, point description, and a minimum of 80 characters alarm message. If an alarm is routed to a workstation display screen, a pop-up window will be displayed on alarm occurrence with the alarm information in the window. The operator shall be able to acknowledge the alarm with a single keystroke or mouse button depression.

Reporting:

The system shall have the ability to provide status reports for the categories of functions noted below:

A. Name:
   All points and point information with the same English name assigned or portion of the same English name assigned.
B. Type:
   All points and point information with the type specifications such as analog or digital.
C. Address:
   List of ASC and DDCs that are within a specified address range.

D. Status:
   All points and point information with a specific status, i.e., all zones in heating, all zones in cooling, all zones unoccupied, or all zones in manual override control.
E. Value:
   All points greater to, equal to, or less than a specified value. For example, report on all zones with temperature greater than 76^{o}F.

Control Summary:

The system shall have the capability to summarize control strategies for any point within the ATC/BAS.

The control summary shall dynamically show all values and point acronyms that make up the control sequence from the input values to the output. These control summaries shall be loggable to a printer for hardcopy.

ASC/DDC Control Configuration:

The operator shall be able to connect directly to a ASC or DDC. Once connected directly to a controller, the operator shall be able to completely configure the controller using a separate window on the workstation. The current configuration of the controller shall be uploaded into the workstation and displayed on the screen. Using menus and prompts the operator shall be able to modify the configuration and re-download the configuration to the connected controller.

ASC/DDC control configurations shall be able to be cloned at the workstation and the same configuration used for other controllers.

Passwords:

The access software shall provide a minimum of 5 levels of passwords. Each level shall be user definable.

1.18 GRAPHICS:

Floor layouts showing rooms, ductwork, and room temperatures. By clicking on the temperature icon, information on the VAV Box, etc. serving that area shall be displayed i.e. flowrate, setpoint adjust, overrides, valve position, fan on, etc.

VAV AHU layout and all associated points.
Heating system and all associated points.
Cooling system and all associated points.

The Graphics shall include the following features:

Home Page
Site plan with link to Floors, or zones color-coded to individual zones, chiller and chilled water pump link (CWS), Boiler and heating water pump link (HWS). Outdoors temp on all graphics. Link to Power page, with link to Modes/schedules

Power page (PDL)
KW in 24-hour graph form and current readout.
Voltage in 24-hour graph form and current readout.

Floor or Zone page
Room Temperature
Room Number to be link to equipment
Exhaust fan link to exhaust fan page
AHU # link to AHU # Page for the appropriate zone or AHU

Equipment page

VAV	Unit heater/CUH
Day/nite status	Day/nite status
Heat/Cool mode	
Room Temp	Room Temp
Room Set point	Room Set point/per CUH
Fan Status Alrm	

Ht Vlv Cmd	Ht Vlv Cmd
Ht Vlv Set pnt	Ht Vlv Set pnt
CFM Min	
CFM Max	
Damper Pos	
Damper cmd	
Discharge Temp	Discharge Temp
Any Radiant heat	
Rad Ht Valve	
Rad Ht Valve cmd	
Unocc. Setpoint(heat)	

Chilled water page

Chiller cmd, status, alarms, Chiller On Set point (OA Temp), Chiller water supply temp, chiller water return temp. And reset schedule with loop supply and return water temperatures and setpoints.
Any changeover valves.
Chilled water Pump(s) command, status, alarm, (able to turn pump on or off)
Chilled water pump(s) primary and secondary VFD status, position and setpoint, and pressure differential status and setpoint
Pump lead/lag and schedule (which pump is currently lead pump).

Boiler Page

Boiler(s) cmd, status, alarms, Boiler On Set point, Boiler water supply temp, boiler water return temp. And reset schedule with loop supply and return water temperatures and setpoints – all 4 points.
Boiler lead lag (which boiler is currently lead).
Any changeover valves.
Hot water Pump(s) command, status, alarm, (flashing) (able to turn pump on or off)
VFD (if Applicable)
Pressure differential and set point.
Pump lead/lag and schedule (which is currently lead pump)
Domestic water Pump status and command (link to Occupied zone) (or its own zone.)
Combustion air graphics
Boiler room temperature control (i.e. dampers, fans)

AHU page

Room temp, and set point if applicable along with the summer mode set point (adjustable)
Economizer Status and set point
Htg Vlv position and command (adjustable)
Clg Vlv position and command (adjustable)
Mixed air damper position and command (adjustable)
Supply air temp and set point (adjustable)
Mixed air temp and set point (adjustable)
Return air temp
Freeze Stat status and alarm (flashing)
VFD position and command
Duct pressure and set point (Adjustable) Location of sensor
Fan status, alarm (flashing) and command (command able)
Building pressure status and set point for dampers/exhaust fans

Smoke dampers (When applicable)
Recirculation mode or Morning warm up mode
Filter Status (When applicable)
Duct High limit status and alarm (When applicable)
Co2/VOC (when applicable)
Day/Night/Summer status
Link to Occupied/unoccupied page
DX Stages

Occupied/Unoccupied/Summer, Mode, or Motor Control Center page
Unit/Zone status
Link to summer schedule
Link to Occupied/unoccupied schedule
Master shutdown link to put all units/zones in unoccupied mode with one calendar or day schedule

Exhaust Fan Page
All exhaust fans
Status and alarm
Link to Occupied/unoccupied zone or schedule

NOTES
All set point to be command able
All Valves, pumps, damper motors to be command able under highest password only
All alarms to be flashing.
All Valves and dampers 0% means closed 100% means open

1.19 SYSTEM ACCEPTANCE:

When the ATC/BAS has been demonstrated to meet the requirements of the Drawings and Specifications the system will be accepted. The warranty period will start at this time.

Operation and Maintenance Manuals:

Submit two (2) copies of operation and maintenance manuals. Include the following in each manual:

A. Manufacturer's catalog data and specifications on all sensors, transmitters, controllers, control valves, damper actuators, gauges, indicators, terminals, and any miscellaneous components used in the system.

B. An Operator's Manual which will include detailed instructions for all operations of the system.

C. An Operator's Reference Table listing the addresses of all connected input points and output points. Settings shall be shown where applicable.

D. A Programmer's Manual which will include all information necessary to perform programming functions.

E. A language manual which will include a detailed description of the language used and all routines used by the system.

F. Flow charts of the software programs utilized in the Control System.

G. Complete program listing file and parameter listing file for all programs.

H. A copy of the warranty.

I. Operating and maintenance cautions and instructions.

J. Recommended spare parts list.

K. After a successful acceptance demonstration, the Contractor shall include record drawings of the completed project for final approval. After receiving final approval, supply three (3) complete record drawing sets, together with Cad diskettes to the owner.

1.20 TRAINING:

BAS manufacturer shall provide to the engineer a training class outline prior to any scheduled training. Training sessions shall be provided for the Owner's personnel by factory trained control engineers and technicians. The ATC/BAS Contractor shall conduct one (1) eight hour and two (2) four hour training courses for the designated owners' personnel in the maintenance and operation of the control system. One class shall be given upon system acceptance and the others within one year after the warranty commences.

The courses shall include instruction on specific systems and instructions for operating the installed system to include as a minimum:

A. HVAC system overview.
B. Operation of Control System
C. Function of each Component
D. System Operating Procedures
E. Programming Procedures
F. Maintenance Procedures

1.21 WARRANTY:

Warranty:

The entire control system shall be warranted to be free from defects in both material and workmanship for a period of two (2) years of normal use and service.

1.22 TESTING AND ADJUSTING:

The Control Contractor shall furnish a competent individual familiar with the installation to assist the Balancing Company and make the necessary control adjustments as directed by the Balancing Contractor.

1.23 SEQUENCE OF OPERATION:

General:

All setpoints shall be adjustable. Deadband settings shall be used where appropriate to minimize cycling of equipment. Minimum on/off times shall be used where appropriate to minimize cycling of equipment.

Outdoor Lighting:

Outdoor lighting shall be controlled from a time schedule. Time schedule shall adjust automatically for time of year. Provide a signal to the lighting contactor in room.

Occupied/unoccupied Zones:

The BAS shall provide separate occupied/unoccupied zone signals for each of the following systems:

1. AHU-1 (Washington)
2. AHU-2 (Washington)
3. AHU-3 (Washington)
4. AHU-4 (Washington)
5. AHU-1 (Madison)
6. AHU-2 (Madison)
7. AHU-3 (Madison)

Fintube Radiation/Hot Water Radiant Ceiling Panels:

The BAS shall maintain the desired space temperature through a DDC controller by modulating a two-way control valve as required. The DDC controllers shall be networked into the BAS to allow for remote adjustments, remote monitoring, and remote temperature indication at the operator's workstation. The DDC controllers shall be Application Specific Controllers (ASC).

Hot Water Cabinet Unit Heaters and Unit Heaters:

The BAS shall maintain the desired space temperature through a DDC controller by cycling the unit fan upon a call for heat in the space. The BAS shall prevent the fan from operating unless 120 degree F. (adj.) hot water is available. The DDC controllers shall be networked into the BAS to allow for remote adjustments, remote monitoring, and remote temperature indication at the operator's workstation, the DDC controllers shall be Application Specific Controllers (ASC).

Fan Powered VAV Terminals with Hot Water Reheat:

The BAS shall control the fan powered VAV terminals through DDC Application Specific Controllers (ASC). The DDC controllers shall be networked into the BAS to allow for remote adjustments, remote monitoring, and remote temperature indication at the operator's workstation.

All VAV boxes shall have a discharge air sensor and shall provide remote temperature indication of the operator's workstation. Temperature indication shall also be integrated into the room VAV graphic display.

During occupied operation, the VAV terminal fan shall run continuously. The ASC shall control the variable air volume terminal unit to maintain the desired space temperature. The ASC shall modulate the supply air damper, and two-way reheat coil valve as required to maintain the heating or cooling setpoint. The supply air volume will be limited by the minimum and maximum heating and cooling air volume settings. The supply air damper shall maintain the minimum air volume setting when the space temperature is below the cooling setpoint. The reheat coil valve shall not open until the space temperature has dropped below the heating setpoint. When commanded by the BAS to change over to the unoccupied mode, the ASC shall raise the cooling setpoint and decrease the heating setpoint as appropriate to operator determined values.

During unoccupied operation, the VAV terminal fan shall be off and the supply air damper shall be closed. The ASC shall maintain the space at its reduced unoccupied temperature setting by cycling the VAV terminal fan on with the reheat coil valve open upon a call for heating in the space. The ASC shall be reset to occupied operation for an operator determined time period by activating a local override switch located on the space temperature sensor.

All fan-powered VAV terminal fans shall be stopped by the ATC/BAS when a general fire alarm is received from the fire alarm system. This Contractor shall obtain the signal from the fire alarm panel.

VAV Terminals with Hot Water Reheat:

The BAS shall control the VAV terminals through DDC Application Specific Controllers (ASC). The DDC controllers shall be networked into the BAS to allow for remote adjustments, remote monitoring, and remote temperature indication at the operator's workstation.

All VAV boxes shall have a discharge air sensor and shall provide remote temperature indication of the operator's workstation. Temperature indication shall also be integrated into the room VAV graphic display.

During occupied operation, the ASC shall control the variable air volume terminal unit to maintain the desired space temperature. The ASC shall modulate the supply air damper and two-way reheat coil valve as required to maintain the heating or cooling setpoint. The supply air volume will be limited by the minimum and maximum heating and cooling air volume settings. The reheat coil valve shall not open until the space temperature has dropped below the heating setpoint. When heating water is available, the reheat valve approaches full open and the heating requirements continues to increase, the heating cfm shall be modulated open to the scheduled heating cfm. When commanded by the BAS to change over to the unoccupied mode, the ASC shall raise the cooling setpoint and decrease the heating setpoint as appropriate to operator determined values.

Toilet Room Exhaust Fans:

This Contractor shall provide an interlock with the BAS so that the exhaust fans run

continuously when their respective zones are in the occupied mode of operation and are off when their zones are in the unoccupied mode of operation.

Provide a current sensor and graphic for equipment status on all building exhaust fans.

Equipment Room Exhaust Fans:

A space temperature sensor shall open the intake air damper and start the exhaust fan if the space temperature rises above 80 degrees F. (adj.)

Provide a current sensor and graphic for equipment status on all building exhaust fans.

Domestic Hot Water Recirculating Pump:

This Contractor shall provide an interlock with the BAS so that the recirculating pump will cycle from an aquastat set at 120 degrees F. (adj.) during occupied operation and shall be off during unoccupied operation.

Hot Water Boiler Control With Full Modulation:

The BAS Contractor shall provide a hand-off-auto switch for automatic or manual control of each boiler. When the switch is in the automatic position, the BAS shall enable the boiler.

Whenever the outdoor air temperature is below 50F (adjustable) the boiler control sequence will be enabled. The DDC controller shall start the hot water circulating pumps and upon proving flow as sensed by the pump status current sensors, the boiler burner will be energized. After a 5 minute delay (adj) to allow for purging and initial burner start up The DDC controller shall modulate the burner through the appropriate interface transducer (current, voltage, or current or voltage to 135 Ohm). The burner will be modulated from low fire to high fire as required to match the system load and maintain the calculated hot water setpoint. The hot water setpoint shall be reset in an inverse ratio with outdoor air from 100F to 160F as the outdoor air temperature ranges from 50F to 0F. All 4 points of the reset ramps shall be adjustable. When the burner has modulated to the low fire position and the load is such that the water temperature to rise above setpoint, the DDC controller will cycle the burner off.

Hot Water Heating Pumps:

The lead hot water heating pump shall be started by the BAS during heating operation below 60 degrees F (ADJ.) outside air temperature. The BAS shall modulate the variable frequency drive for the lead pump to maintain the desired system differential pressure according to a differential pressure sensor located as directed by the Engineer. The second pump shall operate below 10°F (adj.).

Each of the two hot water heating pumps shall have a current switch or differential pressure switch to prove pump operation. If flow is not proven after the BAS has commanded the lead pump to start, an alarm shall be initiated at the operator's workstation and BAS alarm printer and the lag pump shall be started and its variable frequency drive shall be modulated by the BAS to maintain the desired system differential pressure. The BAS Contractor shall provide the necessary programming to lead/lag and alternate the pumps.

Chiller Control:

The BAS Contractor shall provide a hand-off auto switch for automatic or manual control of the chiller. When the switch is in the automatic position, the BAS shall enable the chiller whenever the outside air temperature rises above 60 degrees F. (adj.), and at least (1) AHU capable of cooling is in its occupied mode of operation. The chiller shall not be allowed to start until the primary chilled water pump has started and a flow switch furnished and wired by this Contractor has proven flow through the chiller.

Whenever the chiller is enabled, the chiller control panel shall maintain the desired water temperature through its packaged control system.

The BAS shall provide for a Bacnet IP or Lonmark interface for full diagnostic and adjustment capabilities.

The BAS shall provide 4-20 mA, 2-10 Vdc, or dry contacts as required to accomplish the communication interface signals.

The BAS Contractor shall provide interlock wiring between the chiller, flow switch and remote control panel to control the specified stages of cooling. Verify exact wiring requirements with the chiller manufacturer.

The chiller Bacnet interface software shall display and allow adjustment of all items listed in the chiller microprocessor specification.

Primary Chilled Water Pump:

The BAS shall start the primary chilled water pump whenever the chiller has been enabled to start by the BAS. When the chiller is disabled, the pump shall continue to operate for an adjustable period of time.

The primary chilled water pump shall have a differential pressure switch to prove pump operation. If flow is not proven after the BAS has commanded the pump to start, an alarm shall be initiated at the operator's workstation and BAS alarm printer.

Secondary Chilled Water Pump:

The BAS shall start the secondary chilled water pump whenever the chiller has been enabled to start by the BAS. The BAS shall modulate the adjustable frequency drive for the pump to maintain the desired system differential pressure according to a differential pressure sensor located as directed by the Engineer.

The secondary chilled water pump shall have a current switch or differential pressure switch to prove pump operation. If flow is not proven after the BAS has commanded the pump to start, an alarm shall be initiated at the operator's workstation and BAS alarm printer.

Single Zone AHU Control:

During occupied operation, the AHU fan shall run continuously as determined by the Building Automation System (BAS). When the occupied cycle of operation is initiated, the BAS shall

prevent the AHU outside air damper from opening during morning warm-up. When the space temperature reaches 68 degrees F (adj.), the outside air damper shall open to its minimum position.

The BAS shall maintain the desired space temperature by modulating in sequence the outside air and return air dampers, the two-way (3-way AHU-1) chilled water valve and the two-way (3-way AHU-1) hot water valve.

The BAS with its sensor located in the mixed air shall override all controls and modulate the outside air and return air dampers to prevent the mixed air temperature from falling below 45 degrees F (adj.). The BAS shall return the outside air damper to its minimum position whenever the outside air temperature rises above 75 degrees F (adj.).

The BAS, with its Indoor Air Quality (IAQ) sensor located in the return air, shall override the damper controls as necessary to maintain the minimum and recommended outside air flow rates to obtain acceptable indoor air quality for indoor spaces according to ASHRAE Standard 62-1989.

The BAS shall modulate the relief hood motorized damper whenever the AHU outside air damper opens beyond its minimum position and the static pressure in the area rises above its setpoint. The BAS with its differential pressure sensor located as directed by the Engineer shall maintain the desired positive space static pressure in relation to atmospheric pressure by modulating the motorized dampers on relief hoods.

During unoccupied operation, the AHU fan shall be off and the AHU outside air damper and the gravity relief air dampers shall be closed. The BAS shall modulate the hot water valve to prevent the mixed air temperature from falling below 45 degrees F (adj.). If the space temperature falls below the unoccupied temperature setting, the BAS shall cycle the AHU fan with the hot water valve full open to satisfy the unoccupied space temperature setting. Provide an override time switch located as directed by the Engineer to return the AHU to its occupied mode of operation for a specified period of time.

Provide a discharge air temperature sensor with remote indication at the operator's workstation. Provide a current switch or differential pressure switch across the AHU fan to prove fan operation. Provide freeze protection as previously specified located on the discharge side of the heating coil which will send an alarm to the operator's workstation and BAS alarm printer through the auxiliary contacts, shut off the fan motor, fully close the outside air damper and open the heating coil valve to full flow through the coil whenever the coil outlet air temperature falls below its setting.

VAV AHU Control:

During occupied operation, the AHU fan shall run continuously as determined by the Building Automation System (BAS). When the occupied cycle of operation is initiated, the BAS shall prevent the AHU outside air damper from opening during morning warm-up. When the return air temperature reaches 68 degrees F (adj.), the outside air damper shall open to its minimum position.

The BAS shall maintain the desired discharge air temperature by modulating in sequence the outside air and return air dampers, the two-way chilled water valve, and the two-way hot water

valve. The BAS shall reset the discharge air temperature from 55 degrees F to 65 degrees F (adj.) based on space temperature demands.

The BAS with its sensor located in the mixed air shall modulate the outside air and return air dampers to prevent the mixed air temperature from falling below 45 degrees F (adj.). The BAS shall return the outside air damper to its minimum position whenever the outside air temperature rises above 75 degrees F (adj.).

The BAS, with its Indoor Air Quality (IAQ) sensor located in the return air, shall override the damper controls as necessary to maintain the minimum and recommended outside air flow rates to obtain acceptable indoor air quality for indoor spaces according to ASHRAE Standard 62-1989.

The BAS, with its sensor located as directed by the Engineer in the supply air ductwork, shall maintain the supply air static pressure at 1.25" W.G. (adj.) by modulating the adjustable frequency fan drive on the AHU.

The BAS shall modulate the relief hood motorized damper whenever the AHU outside air damper opens beyond its minimum position and the static pressure in the area rises above its setpoint. The BAS with its differential pressure sensor located as directed by the Engineer shall maintain the desired positive space static pressure in relation to atmospheric pressure by modulating the motorized dampers on relief hoods.

During unoccupied operation, the AHU fan shall be off and the AHU outside air damper shall be closed. Relief dampers shall be closed. The BAS shall modulate the hot water valve to prevent the mixed air temperature from falling below 45 degrees F (adj.).

Provide a current switch or differential pressure switch across the AHU fan to prove fan operation. Provide a freeze protection thermostat as previously specified located on the discharge side of the heating coil which will send an alarm to the operator's workstation and BAS alarm printer through the auxiliary contacts, shut off the fan motor, fully close the outside air damper and open the heating coil valve to full flow through the coil whenever the coil outlet air temperature falls below its setting.

Summer Occupied:

Classroom:	During the summer occupied mode of operation all of the zone setpoints shall be reset to 80oF (adj.). The O/A and R/A dampers shall go to full R/A position. The cooling valve shall modulate to maintain 60oF (adj.) discharge air and the fan VFD shall modulate to maintain 0.5 (adj.) inches static pressure in the S/A d ductwork. The building relief/exhaust fan shall be off.
Gymnasium:	During the summer occupied mode the space setpoint shall be reset to 80oF (adj.). The O/A and R/A dampers shall go to full R/A position. The cooling coil valve shall modulate to maintain space setpoint. The BAS Contractor shall provide a fan schedule to allow the Owner to adjust the hours of fan operation during the occupied period.

Smoke Damper Control:

On interruption of power to an AHU by the fire alarm system, the actuators on the respective system combination fire/smoke damper assemblies shall close the dampers. When power is returned by the reset of the fire alarm system, the dampers shall be opened. Provide all electrical interlocks. The smoke dampers in the ductwork of a particular system shall close whenever that system's fan is not operating. Allow for the dampers to open before the fan is energized. Wiring the smoke dampers is the responsibility of this Contractor. Coordinate the proper electrical characteristics with the Section 230800 Contractor.

Peak Demand Limiting:

This Contractor shall provide the required energy monitor and electrical wiring to connect the BAS to an energy monitor that measures voltage, KW and amperage. It will be the responsibility of the BAS Contractor to coordinate this tie in with Power Company. The BAS Contractor shall provide all necessary programming for peak demand limiting through all applicable points that are connected to the BAS.

END OF SECTION 230900

DIVISION 26-27-28 - ELECTRICAL

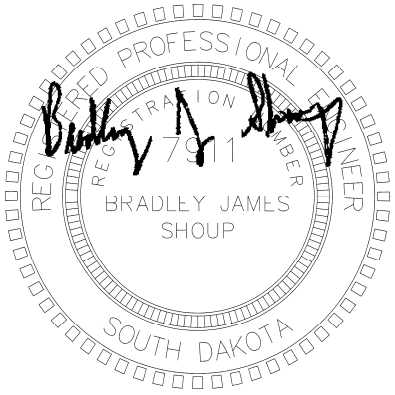
TABLE OF CONTENTS

PROJECT: MADISON & WASHINGTON ELEMENTARY SCHOOLS
ADDITION & RENOVATIONS
HURON, SOUTH DAKOTA

ACEI PROJECT NO.: 113059

DATE: February 19, 2014

Project Manual sections prepared by or under the supervision of Bradley J. Shoup, Reg. No. 7911, include all sections of Divisions 26, 27, and 28.



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SECTION 260100 – COMMON ELECTRICAL REQUIREMENTS

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. In certain instances where the terms of this Division of the Specifications conflict with the terms of the General Conditions, or Special Conditions, this Division of the Specifications shall govern.

B. Note that the complete electrical installation for this project falls under three specification divisions: Division 26, Division 27, and Division 28.

C. The project shall be bid as one complete package with the final electrical construction bid containing all costs for Divisions 26, 27, and 28.

D. The general requirements shown here in this Division 26 section shall also apply to Divisions 27 and 28.

E. Where M.C. or Mechanical Contractor is referenced in Division 26, 27, or 28 specifications or on the electrical drawings, it refers to the general trade. Coordinate in field with the proper Fire Suppression, Plumbing, or HVAC Contractor based on the information in the specification or note.

1.2 SUMMARY

A. This Section shall include everything in Divisions 26, 27, and 28 of the Specifications and everything indicated on the Drawings that are complementary to these Divisions of the Specifications. Refer to the Index of Drawings to determine what Drawings apply directly to this section.

B. Where “Contractor” is referred to in this Division of the Specifications it shall mean Contractor and/or Sub-Contractors responsible for all or any part of the electrical installation specified in Divisions 26, 27, and 28 and/or as shown on the Contract Drawings.

C. Where the specifications in subsequent Sections of Divisions 26, 27, or 28 conflict with requirements of this Section, the specifications in the subsequent Sections shall govern.

D. The contractor shall provide all items, articles, materials, operations or methods listed, mentioned or scheduled on the Drawings and/or herein specified, including all labor, materials, equipment, accessories, wiring, and incidents necessary to be installed in accordance with manufacturer’s recommendations except as otherwise approved.

1.3 INTENT OF PLANS AND SPECIFICATIONS

A. The intent of the plans and specifications are for the complete installation of the system described so that at the conclusion of the construction, the systems will be turned over to the owner complete and ready for safe and efficient operation. The plans and specifications cannot

deal individually with the many incidental items which may be required by the nature of the systems. The contractor shall be obliged to furnish and install all such items normally included on systems of this type, which while not mentioned directly in the drawings and specifications are obviously essential to the installation and operation of the system and which are normally furnished on quality installations of this type.

B. The contractor shall make a thorough inspection of the conditions and be familiar with all conditions affecting the extent and cost of this work. Claims for extra payments as a result to examine the conditions will not be allowed.

1.4 PERMITS AND SERVICE CHARGES

A. All permits and service charges necessary for execution of the work under this Contract shall be obtained by and be paid for by the Contractor. It shall be the responsibility of the Contractor to determine the permit requirements of the local authorities and utility companies and the cost of required permits, service charges, tap fees and development fees shall be included in the Contractor's bid.

B. All work shall be executed in accordance with all local, state, and national rules, regulations, codes, etc., which are applicable and shall be subject to inspection by the proper authorities.

1.5 CODES AND STANDARDS

A. All work performed and all equipment furnished under this Division of the Contract shall be manufactured and installed in strict accordance with all applicable codes and standards, including the applicable provisions of the following codes and standards.
1. Local and State Codes, Standards, and Regulations.
2. NFPA 70, National Electrical Code, Current Addition.
3. National Board of Fire Underwriters (NBFU).
4. National Electrical Manufacturers Association (NEMA).
5. Underwriters Laboratories (UL).
6. Electrical Testing Laboratory (ETL).
7. Illuminating Engineering Society (IES).
8. American National Standards Institute (ANSI).
9. National Fire Protection Association (NFPA).
10. International Building Code (IBC).
11. International Fire Code (IFC).

B. Compliance:
1. Where specific requirements of any code vary with the requirements of another code, the higher standard as determined by the Architect/Engineer shall govern the installation. Contractors shall familiarize themselves with local codes and regulations which affect their work in any way. Extra payment will not be allowed for changes required by local codes and regulations.
2. All equipment manufactured in accordance with the provisions of the above codes and standards shall bear the label of the respective association bureau thereon.

1.6 DRAWINGS AND MEASUREMENTS

A. In general, the Drawings of the electrical systems and equipment are to scale. However, to determine exact locations of walls and partitions, the Contractor shall consult the architectural and/or structural drawings which are dimensioned. Drawings shall not take precedence over field measurements.

B. Drawings of fixtures and devices, although shown on scale drawings, are diagrammatic only. They are intended to indicate size and/or capacity where stipulated, approximate location and/or direction, and approximate general arrangement of one phase of work to another, but not the exact detail or exact arrangement of construction. If it is found, before installation of any or all construction phases, that a more convenient, suitable or workable arrangement of any or all phases of the project would result by varying or altering the arrangement indicated on the Drawings, the Architect/Engineer may require the Contractor to change the location or arrangement of the work without additional cost to the Owner. Such rearrangement shall be in accordance with directions from the Architect/Engineer.

1. Install light fixtures and wiring devices at heights specified in the Electrical Symbol Legend or as shown on the drawings. All measurements are to center unless noted otherwise. Device heights indicated on architectural elevations shall take precedence over symbol legend.

C. Where discrepancies are discovered after certain portions or phases of the work have been installed, the Architect/Engineer reserves the right to require the Contractor to make changes in conduit, fixture or equipment locations or arrangements to avoid conflicts with work at no additional cost to the Owner.

D. Because the Drawings are to a relatively small scale to show as large a portion as is practical, the fact that only certain features of the systems are indicated does not mean that other similar or different features or details will not be required. The Contractor shall furnish all incidental labor, material or equipment for the systems so that each system is a complete and operating one unless otherwise specifically stipulated in the detailed body of the specifications.

E. The Contractor, Subcontractor's and their respective trades shall cooperate in laying out their work so it will fit properly into the space provided. Promptly report to the Architect/Engineer any delay or difficulties encountered in the installation of this work which might prevent prompt and proper installation, or make it unsuitable to connect with or receive the work of others. Failure to so report shall constitute an acceptance of the work of other trades as being fit and proper for the execution of this work.

1.7 SUBSTITUTIONS AND PRODUCT OPTIONS

A. The Contractor and equipment suppliers shall read and familiarize themselves with articles concerning substitution of materials, as indicated in the Instructions to Bidders. Material and equipment substitutions will be handled as follows:

B. Materials or equipment specified by name of manufacturer, brand, trade name or catalog reference, shall be furnished under the contract unless changed by Addenda or a Contract modification. Where two (2) or more materials are named, the choice of these shall be optional with the Contractor.

C. Material or equipment followed by the phrase "or equal" shall establish a standard of required function, dimension, appearance and quality to be met by any proposed substitute. No substitution will be considered unless written request for substitution has been submitted by the

bidder and has been received by the Architect/Engineer at least seven days prior to the date for receipt of bids. The Architect/Engineer's decision on a proposed substitute shall be final. If the Architect/Engineer considers any proposed substitution equal, such will be set forth in an Addendum. Bidders shall not rely upon substitutions made in any other manner.

D. Whenever an item of material or equipment is identified on the drawings or specifications by reference to brand name or catalog number, it shall be understood that the reference is made for the purpose of defining the performance or other salient requirements and that other products of equal capacities, quality, or function may be considered.

E. The listing of any manufacturer preceded by the phrase “or equal by” does not imply automatic approval. It is the sole responsibility of the Contractor to ensure that any price quotations received and submittals made are for products which meet or exceed the specifications included herein. The Contractor must judge that such items of substitution are of equal quality and character to the specified items and it is physically adaptable for installation within the allotted space with all required service clearances. The cost of any changes to other trades as a result of use of the substitution material or equipment must be borne by the Contractor submitting such material or equipment.

F. Should the Contractor wish to use materials or equipment other than those specified or listed as equal by Addenda, he shall attach his proposed substitution along with full descriptive and technical data for the proposed item with the appropriate add or deduct to the Contract amount, should the substitution be accepted. Substitutions proposed by the Contractor will not be considered in the award of the Contract.

G. After the award of the Contract, any request for a substitution must be made in writing by the Contractor (not the material supplier or subcontractor). Such request shall state the name of the product specified, the name of the product proposed for substitution, the reason for requesting the substitution, and any change to the Contract amount resulting from the substitution. No such substitution shall be made until an appropriate Contract modification has been issued and approved.

1.8 SUBMITTALS

A. Schedule of Materials and Equipment:
   1. The Contractor shall submit a complete list of proposed equipment manufacturers for major systems and a list of Sub-Contractors, for the Engineer’s review. This list shall be submitted for review within 15 days after the contract award and before ordering any material or equipment.
      a. Review of the list shall in no way relieve the Contractor from the responsibility of submitting complete shop drawings nor shall it constitute approval should the shop drawings be found to be partially or completely not in full compliance with the specification requirements.

B. Schedule of Values:
   1. The Contractor shall submit an itemized schedule of values for the various portions of the work, including separation of labor and materials for each item, to the Engineer before submission of the first Request for Payment. The schedule of values shall be divided so as to facilitate the Engineer’s analysis of the various costs for the purpose of approval of the payment requests. The submittal shall meet the approval of the Engineer before any progress payment will be provided. The following are required categories for the cost breakdown.

a. Service and Distribution Equipment.
b. Lighting.
c. Wiring Devices.
d. Equipment Connections.
e. Basic Materials.
f. Special Systems.

C. Shop Drawings:

1. Refer to the requirements of the General Conditions. Unless indicated otherwise in the General Conditions, submit to the Architect/Engineer seven (7) copies (minimum) of Shop Drawings for each item of equipment to be installed under this contract with two (2) copies to be retained by the Architect/Engineer. Furnish additional Shop Drawings as required for coordination with General Contractor and other Subcontractors. Furnish Shop Drawings as follows:
   a. For all major items of equipment or materials, regardless of whether the item is to be furnished as specified.
   b. For all equipment, systems or devices where Shop Drawings are specifically called for.
   c. For all minor items of equipment or materials where the Contractor proposes to deviate from the specified and/or scheduled manufacturer or material.
   d. Shop drawings shall include manufacturer, catalog number, voltage and current characteristics, wire sizes, construction, and rough-in data of all materials to be used. Each product data sheet shall clearly indicate the proposed product.
   e. Major components of Divisions 26, 27, and 28 shall be submitted at one time. All such literature shall be bound in amply sized three-ring binders with table of contents and tabbed sections separating and identifying the sections of the shop drawings. Tabbed sections shall correspond with Divisions 26, 27, and 28 specification sections.
2. The Contractor shall check all Shop Drawing submittals for compliance with Contract Documents, for size, capacity, arrangement, connection locations, materials, finish, color, electrical characteristics, accessories, and shall so note the Shop Drawings prior to submittal to the Architect/Engineer. Any deviation from the Drawings and Specifications shall be indicated.
   a. Each shop drawing shall be certified as being checked and approved by the Contractor before submittal. Shop drawings not indicated as being approved by the Contractor will be returned without review.
3. Shop Drawings will be reviewed by the Architect/Engineer, and copies of Shop Drawings will be returned to the Contractor. Shop Drawings shall be submitted sufficiently in advance of the construction schedule to allow time for checking Drawings, resubmittal and rechecking when necessary.
4. Any equipment or material which is installed without authorization by properly processed Shop Drawings will be subject to removal by the Contractor and reinstallation as directed, without cost to the Owner. All cost for repair for damages as may be incurred to the structure as a result of the above correction shall be paid by this Contractor.
5. Shop drawing material quantities will not be checked by the Architect/Engineer, and review of Shop Drawings by the Architect/Engineer shall not be construed to be verification of the material quantities and sizes shown on the Shop Drawings. Quantities, sizes, dimensions and locations shown on the Drawings and as specified shall determine material requirements.
6. The Contractor shall maintain two (2) copies of approved shop drawings to be submitted with the Operating and Maintenance Manuals.

1.9 QUALITY ASSURANCE

A. Materials and equipment shall be new and of the best quality, of the type best suited for the purpose intended, and be made by nationally recognized and substantially established manufacturers. The type and weight of material used for each purpose shall be as herein specified, and material shall conform to the requirements of the latest standard specifications of the "ASTM" for that particular material.

B. All materials and equipment shall be listed, labeled, or certified by a nationally recognized testing laboratory to meet Underwriters Laboratories, Inc., standards where test standards have been established.
   1. Equipment and materials which are not covered by UL Standards will be accepted provided equipment and material is listed, labeled, certified, or otherwise determined to meet safety requirements of a nationally recognized testing laboratory.
   2. Equipment of a class which no nationally recognized testing laboratory accepts, certifies, lists, labels, or determines to be safe, will be considered if inspected or tested in accordance with national industrial standards, such as NEMA, or ANSI. Evidence of compliance shall include certified test reports and definitive shop drawings.

C. The installation work included in this specification shall be performed in a neat workmanlike manner by persons experienced and skilled in the Electrical trade. Only the best quality workmanship will be accepted. All exposed parts of the electrical wiring systems such as exposed conduits, flush plates, cabinet trims, fixtures, etc., shall be square and true with the building construction.

1.10 COORDINATION OF WORK

A. The Mechanical and Electrical Contractors and their Subcontractors shall have coordination meetings to facilitate the installation of equipment, ducts, pipes, electrical panels and equipment, and other miscellaneous equipment. The Mechanical Contractor and Electrical Contractor shall coordinate the location of all equipment during the coordination meetings to prevent interferences between equipment of different systems. Any conflicts that may be discovered during the coordination meetings shall be brought to the immediate attention of the Engineer.

B. The Contractor shall order equipment and materials in a timely manner and shall be responsible for close correlation of the work with that of all other Contractors on this project so that it will not interfere with or delay the work of other Contractors. The Contractor shall confer and cooperate with all other Contractors on this project and shall arrange the work in proper relation to the work of others.

1.11 RECORD DRAWINGS AND OPERATING AND MAINTENANCE MANUALS

A. Record Drawings:
   1. The Contractor shall keep a complete set of all electrical drawings in the jobsite office for purpose of showing the installation of electrical systems and equipment. This set of drawings shall be used for no other purpose. Where any materials equipment or system components are installed different from that shown on the Architect/Engineer's drawings, such differences shall be clearly and neatly shown on this set of drawings using ink or indelible pencil. At the completion of the project, the record set of drawings shall be turned over to the Architect/Engineer and shall become his property.

a. Incorporate all changes made by addendum, shop drawing review, change order, and field orders.

B. Operating and Maintenance Manuals:
1. The Contractor shall furnish the Owner with two (2) sets of complete catalog data (approved shop drawings), manufacturer's literature and detailed manuals covering the operation and maintenance of all equipment specified under this Division.
   a. Comply with Division 1 requirements.
   b. The manual shall indicate the Contractor's name, address, and phone number and include a list of all Subcontractors, including company name, address, and telephone number.
   c. The manual shall include, but not be limited to, the following: Installation instructions; maintenance and overhaul instructions; procedures for start, operation, and shut down of equipment and systems; complete wiring and control diagrams; cleaning of lighting fixtures lenses and other equipment; safety precautions; diagrams and illustrations; manufacturers' name and catalog data; test procedures; name and address of authorized service organizations; and parts distributor for all material and equipment installed. Include all special warranty statements for all special warranties required by contract documents.
   d. The manual shall include a complete inventory list of all extra materials which are specified to be provided in the Contract.
   e. All such literature shall be bound in an amply sized three-ring binder with table of contents and tabbed sections separating and identifying the sections of the manual.
2. The Contractor shall supervise the initial operation of all equipment and instruct the Owner's designated operator or maintenance representative in such operation as to acquaint the operator thoroughly with the equipment.

C. Testing:
1. Work which is required to be placed within the construction or concealed shall be carefully tested and inspected before being permanently concealed.
2. The Contractor shall provide all testing instruments, equipment, and all materials, connections, labor, etc., required to perform tests.
3. Test all circuits, fixtures, equipment, and systems for proper operation and freedom from grounds, shorts, and open circuits before acceptance is requested.
4. Provide complete operational sequence checkout to verify all modes of operation both normal and alarm for each system. Test all control systems that interact with each other as a complete system to demonstrate that all interconnections and interactions are correct and that all interconnect wiring is functional.
5. Perform all tests required by local authorities, such as tests of life safety systems, in addition to tests specified herein. Perform tests required by other specification sections.
6. Tests shall be made in the presence of the Engineer and the Owner, and shall meet with their approval. The Contractor shall notify the Engineer at a time sufficiently prior to the performance of any test to allow time for the engineer to be present for the test.
7. The entire system shall be subject to a test at full operating and under normal usage conditions. This shall include voltage and current checks, resistance measurements, and equipment operation. Failure of any phase of system operation shall constitute failure of the system. Correct failures and retest system. Repeat until the system is operating to required specifications.
   a. Submit dated "Electrical System Test Reports" indicating all tests performed and demonstrating conformance with the required system performance criteria in tabular form.
8. After testing the apparatus, the entire system shall be operated for one week under normal conditions.

9. The final testing shall be performed as soon as possible after the work is entirely completed.

1.12 FINAL INSPECTION

A. Upon completion of the work, the Contractor shall notify the Architect and/or Engineer and make arrangements for a final inspection. The Contractor shall submit the operation and maintenance manuals prior to the final inspection; the Engineer will not schedule nor perform a final inspection without successful submittal of operating and maintenance manuals by the Contractor.
   1. During the final inspection and subsequent follow-up final inspection, the Contractor and all major Sub-Contractors shall have the foreman of the project present.

B. After the Engineer's final inspection is made, the Contractor will receive a list of items requiring adjustment, correction, replacement, or completion.

C. The Contractor shall comply completely with all the listed requirements within thirty (30) days of receipt of the list. Should the Contractor fail to perform within this time limit, the Owner reserves the right to have the work completed by others and the cost deducted from the contract price.

D. The Contractor shall notify the Architect and/or Engineer once all listed requirements are completed, that the Contractor is ready for a follow-up final inspection. The written notice shall contain explanations for those known items not completed and a schedule for completing them.

E. The Architect and/or Engineer shall schedule a follow-up final inspection to confirm completion of all listed requirements. Repeated inspection trips required of the Engineer due to the Contractor's inability to complete the project satisfactorily will require the Contractor to reimburse the engineer for all incurred costs after the follow-up final inspection.

1.13 GUARANTEE

A. The Contractor shall assume responsibility for any defects which may develop in any part of his work caused by faulty workmanship, material or equipment, and agrees to replace, repair, or alter, at the Contractors expense, any such faulty workmanship, material, or equipment that has been brought to the Contractors attention during a period of one year from the date of the final certificate for payment. Acceptance of the work shall not waive this guarantee.
   1. Refer to Divisions 26, 27, and 28 Specifications for additional special equipment warranties.

END OF SECTION 260100

SECTION 260500 - 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 1 Specification Sections, apply to this Section.

B. In certain instances where the terms of this Division of the Specifications conflict with the terms of the General Conditions, or Special Conditions, this Division of the Specifications shall govern.

1.2 SUMMARY

A. This Section includes the following:

1. Supporting devices for electrical components.
2. Electrical identification.
3. Electricity-metering components.
4. Concrete equipment bases.
5. Firestopping
6. Electrical demolition.
7. Cutting and patching for electrical construction.
8. Touchup painting.

1.3 SUBMITTALS

A. Product Data: Include manufacturer product data sheets for underground warning tape, electric metering equipment, and firestopping materials to be utilized on this project.

1.4 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.

1.5 COORDINATION

A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.

1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.

B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the work. Coordinate installing large equipment requiring positioning before closing in the building.

C. Coordinate electrical service connections to components furnished by utility companies.

1. Coordinate installation and connection of exterior underground utilities and services, including provision for electricity-metering components.
2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.

D. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces. Access doors and panels are specified in Division 8 Section "Access Doors."

E. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.

F. Where electrical identification markings and devices will be concealed by acoustical ceilings and similar finishes, coordinate installation of these items before ceiling installation.

PART 2 - PRODUCTS

2.1 SUPPORTING DEVICES

A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.

B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.

C. Slotted-Steel Channel Supports: Flange edges turned toward web, and 9/16-inch- (14-mm-) diameter slotted holes at a maximum of 2 inches (50 mm) o.c., in webs.

1. Channel Thickness: Selected to suit structural loading.
2. Fittings and Accessories: Products of the same manufacturer as channel supports.

D. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers. Wire hangers shall not be utilized for supporting raceway or boxes (except for supporting raceways installed within steel stud walls where raceways are supported from the studs).

E. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.

F. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable-iron casting with hot-dip galvanized finish.

G. Expansion Anchors: Carbon-steel wedge or sleeve type.

H. Toggle Bolts: All-steel springhead type.

2.2 ELECTRICAL IDENTIFICATION

A. Identification Devices: A single type of identification product for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.

B. Colored Adhesive Marking Tape for Raceways: Self-adhesive vinyl tape, not less than 1 inch wide by 3 mils thick (25 mm wide by 0.08 mm thick).

C. Underground Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape with the following features:

1. Not less than 6 inches wide by 4 mils thick (150 mm wide by 0.102 mm thick).
2. Compounded for permanent direct-burial service.
3. Embedded continuous metallic strip or core.
4. Printed legend that indicates type of underground line.

D. Tape Markers for Wire and Cables: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.

E. Color-Coding Cable Ties: Type 6/6 nylon, self-locking type. Colors to suit coding scheme.

F. Engraved-Plastic Labels, Signs, and Instruction Plates: Engraving stock, melamine plastic laminate punched or drilled for mechanical fasteners 1/16-inch (1.6-mm) minimum thickness for signs up to 20 sq. in. (129 sq. cm) and 1/8-inch (3.2-mm) minimum thickness for larger sizes. Engraved legend in black letters on white background.

G. Interior Warning and Caution Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145. Preprinted, aluminum, baked-enamel-finish signs, punched or drilled for mechanical fasteners, with colors, legend, and size appropriate to the application.

H. Exterior Warning and Caution Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145. Weather-resistant, non-fading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm), galvanized-steel backing, with colors, legend, and size appropriate to the application. 1/4-inch (6-mm) grommets in corners for mounting.

I. 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 EQUIPMENT FOR UTILITY COMPANY'S ELECTRICITY METERING

A. Current-Transformer Cabinets: Comply with requirements of electrical power utility company.

B. Meter Sockets: Comply with requirements of electrical power utility company.

2.4 CONCRETE BASES

A. Concrete Forms and Reinforcement Materials: As specified in Division 3 Section "Cast-in-Place Concrete."

B. Concrete: 3000-psi, 28-day compressive strength as specified in Division 3 Section "Cast-in-Place Concrete."

2.5 FIRESTOPPING

A. Conduit, cable penetrations, and any other electrical equipment penetrations of fire rated construction, equipment rooms, and/or where designated on the Drawings shall be sealed with a fire retardant sealant similar to:
   1. Specified Technologies, Inc. (STI) SpecSeal Series SSS Intumescent Sealant.
   2. STI SpecSeal Series LCI Intumescent Sealant.
   3. STI SpecSeal Series SST Firestop Putty.
   4. STI SpecSeal Series SSB Firestop Pillows.
   5. STI Pensil 200 Silicone Foam.
   6. STI EZ-PATH Fire Rated Pathway or Hilti Speed Sleeve.

B. Fire sealants shall be Specified Technologies, Inc., 3M Fire Protection Products, A/D Fire Protection Systems, Inc., Hilti Inc., Nelson Firestop Products, or equal.

   1. Firestopping materials shall be low VOC.

C. Obtain through-penetration firestop systems from a single manufacturer with experienced installers having the necessary experience, staff, and training to install manufacturer's products per project requirements.

2.6 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.

PART 3 - EXECUTION

3.1 ELECTRICAL EQUIPMENT INSTALLATION

A. The installation shall be in accordance with the latest requirements of the NEC, State, and Local Codes, ordinances and regulations of any other governing body having jurisdiction

B. All equipment shall be installed in a neat and workmanlike manner and to the satisfaction of the Project Engineer.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.

D. Equipment Rooms: Line walls where electrical equipment is to be mounted with ¾" plywood backboards. Paint backboards with two coats of low VOC gray fire retardant paint.
   1. Where equipment is installed in rooms being used as return air plenums, electrical equipment shall be mounted to Hoover Treated Wood Products Pyro-Guard backboards.

E. Mount panelboards, contactors, and other electrical equipment on backboards, unless otherwise indicated.

F. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

G. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.

H. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 ELECTRICAL SUPPORTING DEVICE APPLICATION

A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.

B. Dry Locations: Steel materials.

C. Support Clamps for PVC Raceways: Click-type clamp system.

D. Selection of Supports: Comply with manufacturer's written instructions.

E. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb (90-kg) design load.

3.3 SUPPORT INSTALLATION

A. Install support devices to securely and permanently fasten and support electrical components.

1. Wire hangers are not an acceptable support component for supporting raceways and boxes (except for supporting raceways installed within steel stud walls where raceways are supported from the studs).
2. Nothing shall rest on, or depend for support on, suspended ceilings (tiles, lath, plaster, as well as splines, runners, bars, and the like in the plane of the ceiling).
3. Support raceways at intervals no greater than ten feet and with one support within three feet of each coupling, box, fitting, or outlet box. Provide one support within three feet of each elbow or bend.

B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.

C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.

D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.

E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.

F. Install 1/4-inch- (6-mm-) diameter or larger threaded steel hanger rods, unless otherwise indicated.

G. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2-inch (38-mm) and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.

H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.

I. Simultaneously install vertical conductor supports with conductors.

J. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches (610 mm) from the box.

K. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.

L. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.

M. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:

1. Wood: Fasten with wood screws or screw-type nails.
2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
3. New Concrete: Concrete inserts with machine screws and bolts.
4. Existing Concrete: Expansion bolts.
5. Steel: Welded threaded studs or spring-tension clamps on steel.

    a. Field Welding: Comply with AWS D1.1.

6. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
7. Light Steel: Sheet-metal screws.
8. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

3.4 IDENTIFICATION MATERIALS AND DEVICES

A. Install at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations indicated in the Contract Documents or required by codes and standards. Use consistent designations throughout Project.

C. Self-Adhesive Identification Products: Clean surfaces before applying. Self adhesive identification products are not approved for electrical equipment enclosure labels.

D. Identify raceways and cables with color banding as follows:

1. Bands: Pretension, snap-around, colored plastic sleeves or colored adhesive marking tape. 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 (8-m) maximum intervals in congested areas.
3. Colors: As follows:

    a. Fire Alarm System: Red.
    b. Security System: Blue.
    c. Telecommunication Systems: Green.
    d. Paging Intercom and Sound Systems: Yellow.

E. Tag and label circuits. Identify source and circuit numbers in each cabinet, pull and junction box, and receptacle outlet box. Color-coding may be used for voltage and phase identification. Neatly mark junction box covers (outside of box where concealed in building finishes or in unfinished spaces, inside of box in finished public spaces) with voltage, source and circuit numbers with permanent black marker.
1. Feeder and Power Circuit Identification: Use plasticized card stock for cables, feeders, and power circuits in pull boxes and electrical rooms.
    a. Legend: ¼" steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.
    b. Fasten tags with nylon cable ties, fasten bands using integral ears.
2. Apply identification to conductors as follows:
    a. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color coding for voltage and phase indication of secondary circuit.
    b. Multiple Control or Communications 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 type.

F. Equipment Identification: Apply equipment identification labels of engraved plastic laminate on each major piece of equipment. This includes communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Provide labels for the following types of equipment.
1. Switchboards, distribution panels, panelboards, and electrical enclosures. Access doors and panels for concealed electrical items.
2. Enclosed controllers, indicate which motor or piece of equipment the unit is serving.
3. Enclosed switches and circuit breakers, indicate which motor or piece of equipment the unit is serving.
4. Service Equipment: Service equipment in other than dwelling units shall be legibly marked in the field with the maximum available fault current. The field marking(s) shall include the date the fault current calculation was performed.
5. Lighting control panels and contactors.
6. Fire alarm control panel.
7. Sound system equipment racks.

G. Install continuous underground warning tape during trench backfilling, for exterior underground power, control, signal, and communication lines, locate marker directly above power and communication lines. Locate approximately 8 inches below finished grade. If 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.

H. Color-code 208/120-V system secondary service, feeder, and branch-circuit conductors throughout the secondary electrical system as follows:

1. Phase A: Black.
2. Phase B: Red.
3. Phase C: Blue.

I. Install warning, caution, and instruction signs where required to comply with 29 CFR, Chapter XVII, Part 1910.145, and where needed 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.

J. Install engraved-laminated emergency-operating signs with white letters on red background with minimum 3/8-inch- (9-mm-) high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

3.5 UTILITY COMPANY ELECTRICITY-METERING EQUIPMENT

A. Install equipment according to utility company's written requirements. Provide grounding and empty conduits as required by utility company.

3.6 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 2 inches larger, in both directions, than supported unit. Follow supported equipment manufacturer's anchorage recommendations and setting templates for anchor-bolt and tie locations, unless otherwise indicated. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete."

B. The Electrical Contractor shall size and provide the concrete and installation associated with the following items as called out elsewhere in the plans and specifications:
1. Utility Transformer Pad.
2. Light Pole Bases.

C. Provide “house keeping pads” for all floor mounted electrical components, including transformers, switchboards, distribution boards, and motor controls centers. Pads shall be a minimum of 4” thick and comply with parts 2 and 3 of this specification section.

3.7 FIRESTOPPING

A. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly.

3.8 DEMOLITION

A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.

B. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.

C. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches (50 mm) below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.

D. Remove demolished material from Project site.

E. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

3.9 CUTTING AND PATCHING

A. 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.

B. 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.

3.10 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work, including the following:

1. Supporting devices for electrical components.
2. Electrical identification.
3. Electricity-metering components.
4. Concrete bases.
5. Firestopping materials.
6. Electrical demolition.
7. Cutting and patching for electrical construction.
8. Touchup painting.

3.11 REFINISHING AND TOUCHUP PAINTING

A. Refinish and touch up paint. Paint materials and application requirements are specified in Division 9 Section "Painting."

1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.12 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.

SPECIFICATIONS
FOR
TRANSFORMER PADS
OCTOBER 1997

* DENSITY TESTS NOT REQUIRED IF USING THE 3/4" CRUSHED GRANITE OPTION

(1) **Sub-grade Cable Well** - A sub-grade, as illustrated on the drawings, shall be prepared and compacted to 95% of AASHO T99 (one density test required) *

(2) **Sub-base Cable Well** - A gravel sub-base, as illustrated in some of the drawings, shall be prepared and compacted to 95% of AASHO T99 (one density test required) *

(3) **Sub-grade Concrete Pad**- A sub-grade, as illustrated on the drawings, shall be prepared and compacted to 95% of AASHO T99 (two density tests required) *

(4) **Sub-base Concrete Pad** - A gravel sub-base, as illustrated in some of the drawings, shall be prepared and compacted to 95% of AASHO T99 (two density tests required) *

(An acceptable substitute for the compacted sub-grade and sub-base shall be 18 inches of 3/4" Crushed Granite. The Crushed Granite shall be placed by excavating to a depth of 18 inches below the finished sub-base elevation and backfilling with the Crushed Granite.)

(5) **Density Test** - Density test shall be in accordance with AASHO T-191 (density of soil in place by the Sand Cone Method), or ASTM D2922-78 (density of soil and aggregate in place by Nuclear Methods, Shallow Depth). A copy of all density test(s), including moisture - density relations of soils, shall be provided to Northwestern's Area Manager or his representative prior to the setting of forms.

(6) **Conduit** - Conduit size and placement shall be in accordance with the plans or as instructed by Northwestern. All conduit shall be installed prior to compaction of sub-grade.

(7) **Backfill** - All backfill over conduit and below sub-grade shall be compacted to a density equal to existing soil conditions (density test not required). All backfill around cable well shall be placed in lifts not to exceed eight (8) inches and shall be compacted to a density equal to the surrounding soil conditions (density test not required).

(8) **Reinforcement** - All steel reinforcement shall be deformed bars and shall conform to AASHTO M 31 Grade 60.

(9) **Concrete** - Concrete used shall have 5-1/2 bags of cement per cubic yard of concrete and shall attain 3500-PSI compressive strength in 28 days. Two concrete test cylinders for each pad shall be made and broken at 7 and 28 days. Copies of each break shall be provided to Northwestern's Area Manager or his representative.

Course aggregate used in the concrete shall be ***crushed granite*** and not crushed rock or gravel.

Concrete shall be cured for a minimum of seven (7) days before the placement of any equipment.

Concrete shall not be poured until the compacted sub-base and steel reinforcement have been approved by Northwestern.

10. **General Guide**

Check with the local operating area, or regional office, of NWE for any additional specifications or requirements pertinent to your local area before excavating for the transformer pad or foundation.

Refer to Standard 30-D for Location Planning Requirements for Padmounted Equipment.

11. **Conduit**

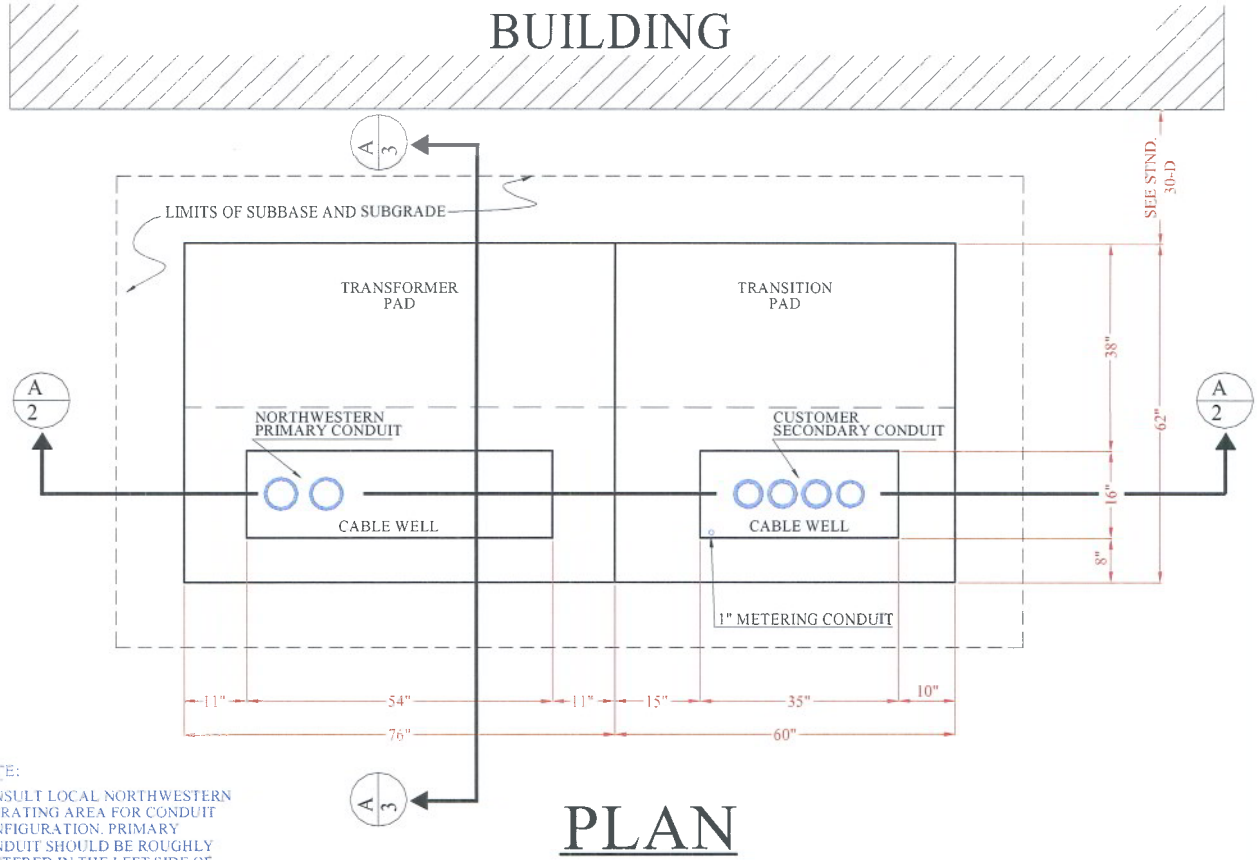
In the following drawings conduit is shown for reference purposes. Prior to excavating obtain a conduit schedule and a layout drawing from the local office of NWE prior to excavating for the pad or foundation.

Install conduits as per the schedule and layout drawing supplied by NWE. Ensure that the conduits are stubbed out a minimum of 10' beyond the limits of the pad. If the conduit stubs are to be buried and then dug up at a later date for use, then:

- Cap the ends of the conduit to keep dirt and debris out.
- Mark the ends with some type of durable marker, such as a vertical piece of conduit, so that the conduit stub location will be readily identified when it comes time to excavate down to the conduit stubs.

12. **Ground Rods**

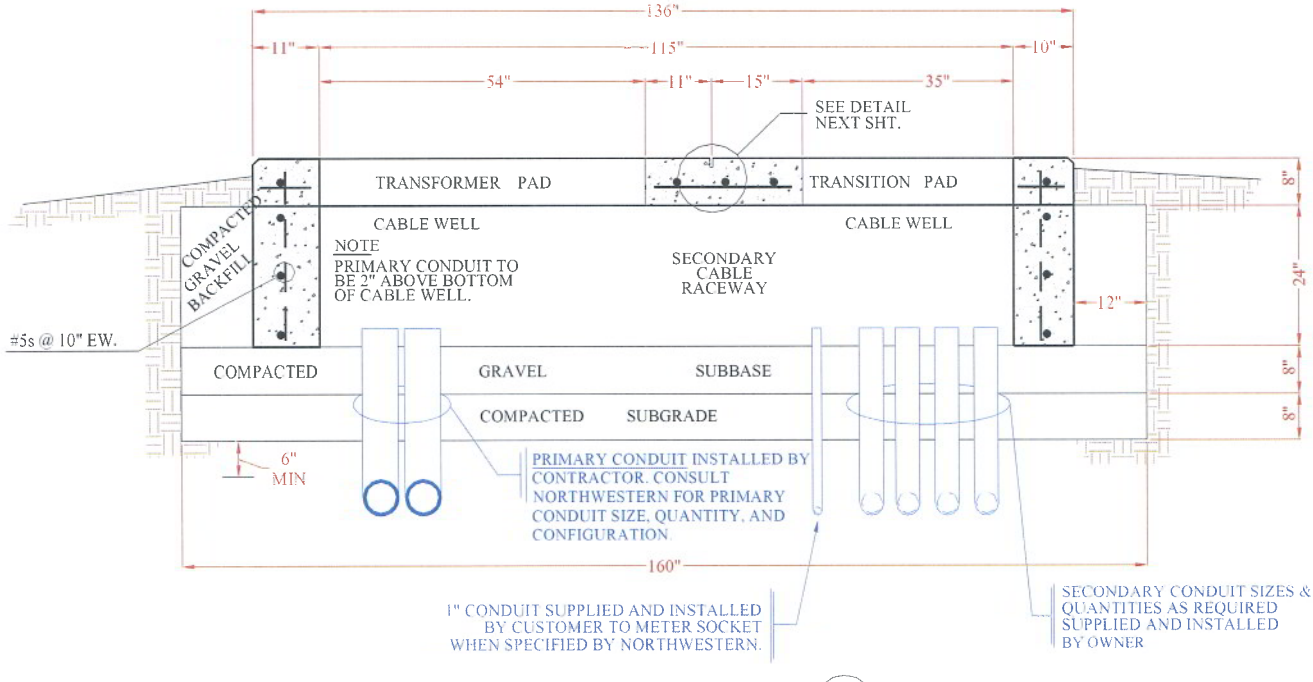
Ground rods can be installed at the time when the conduits are being placed in the excavation and the sub-base is being prepared. See Transformer Standards (*Standard 35)* for details on locating the ground rods in a transformer pad and Underground Equipment Standards (*Standard 33*) for locating ground rods in other types of padmounted equipment. Often a ground rod can be used to help stabilize the conduit elbows during backfill and compaction.



NOTE:

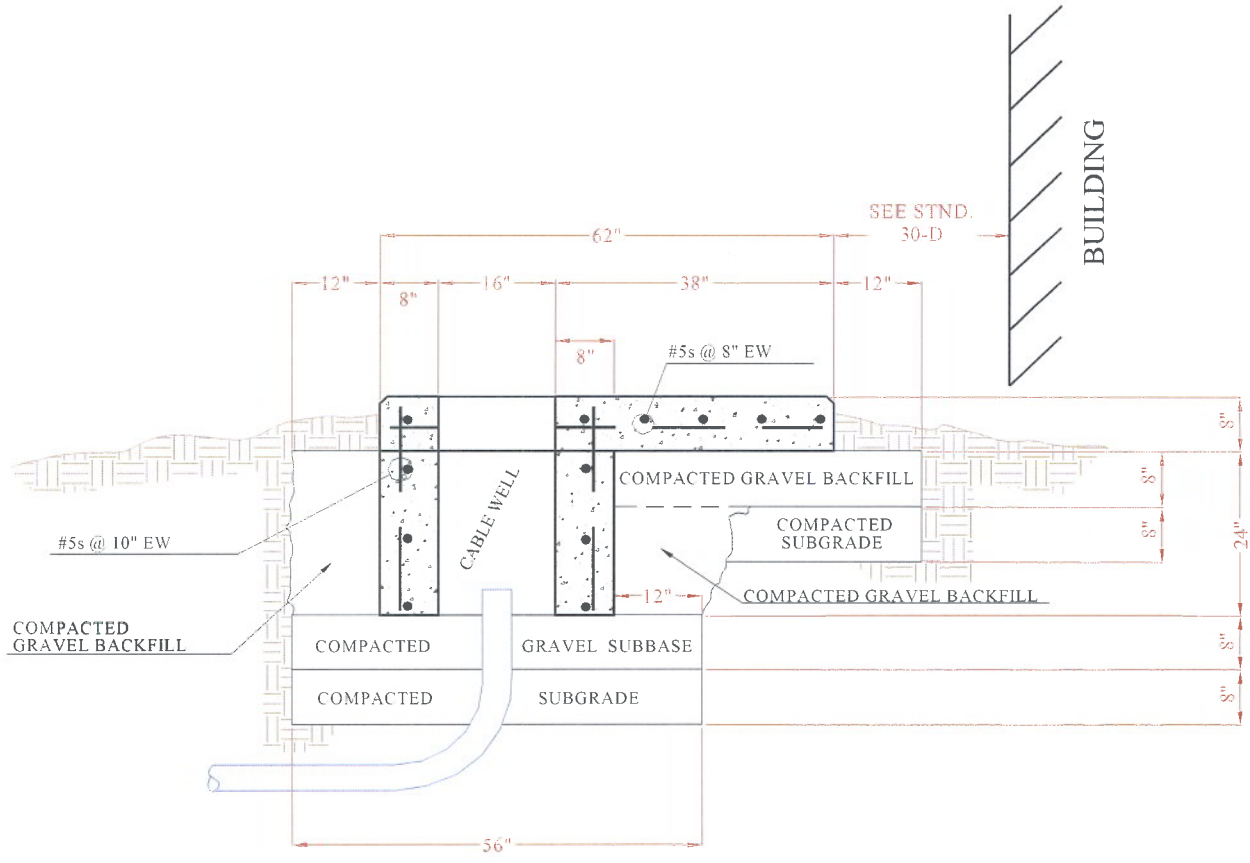
CONSULT LOCAL NORTHWESTERN OPERATING AREA FOR CONDUIT CONFIGURATION. PRIMARY CONDUIT SHOULD BE ROUGHLY CENTERED IN THE LEFT SIDE OF THE OPENING.

PLAN

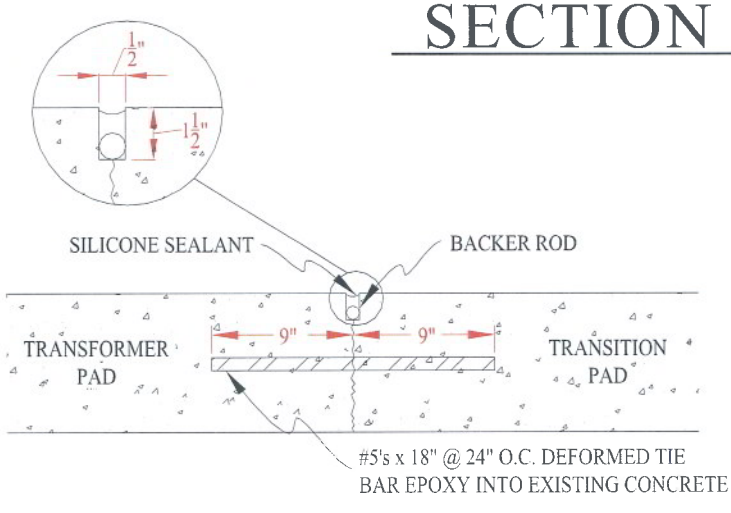


SECTION A 2

NorthWestern Energy	Electric Construction Standards - *Distribution Underground*	STANDARD NO.	
	CONCRETE PADMOUNT FOUNDATIONS W/ TRANSITION CABINET (THRU 500 kVA)	**36-C-8**	
REV NO.0 | 06/01/2006		06/01/2006	Sht. 1 of 2



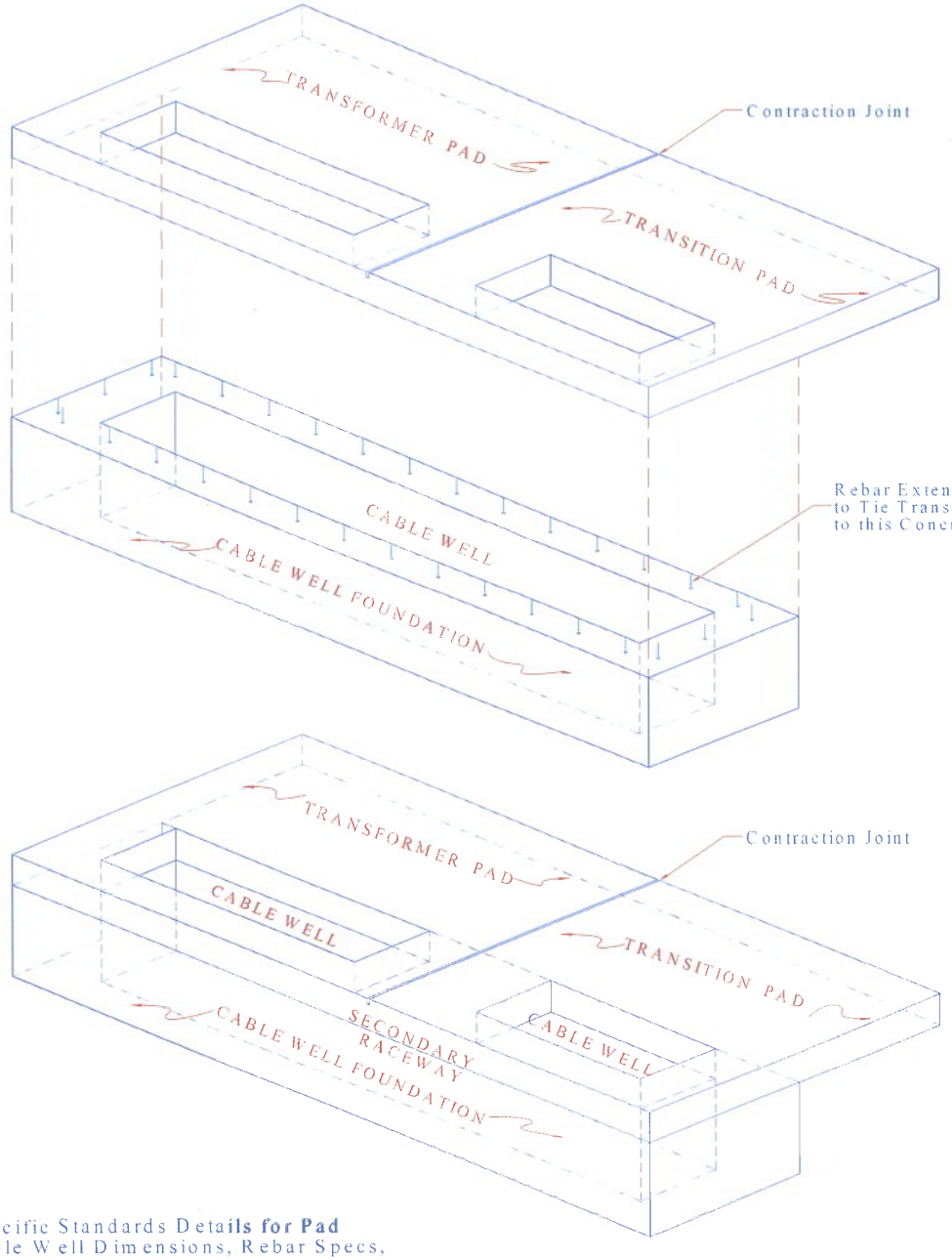
SECTION A/3



CONTRACTION JOINT DETAIL

CONSTRUCTION NOTES:

1. FOR PAD AND BASE SPECIFICATIONS, *SEE STANDARD 36-C-1.*
2. FOR LOCATION PLANNING REQUIREMENTS, *SEE STANDARD 30-D.*



Note:
See Specific Standards Details **for Pad** and Cable Well Dimensions, Rebar Specs, Subbase/Subgrade Specifications, and Contraction Joint Detail.

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SECTION 260600 - 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. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

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.

1. Comply with UL 467.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Grounding Conductors, Cables, Connectors, and Rods:

a. Chance/Hubbell.
b. Copperweld Corp.
c. Erico Inc.; Electrical Products Group.
d. ILSCO.
e. O-Z/Gedney Co.; a business of the EGS Electrical Group.
f. Raco, Inc.; Division of Hubbell.
g. Superior Grounding Systems, Inc.
h. Thomas & Betts, Electrical.

2.2 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 26 Section "Conductors and Cables."

B. Equipment Grounding Conductors: Insulated with green-colored insulation.

C. Grounding Electrode Conductors: Stranded copper cable, #4 AWG minimum.

D. Underground Conductors: Bare, tinned, stranded copper, unless otherwise indicated.

E. Bare Copper Conductors: Comply with the following:

1. Solid Conductors: ASTM B 3.
2. Assembly of Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.

F. Copper Bonding Conductors: As follows:

1. Bonding Cable: Minimum size of 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch (6.4 mm) in diameter.
2. Bonding Conductor: Minimum size of No. 6AWG, stranded copper conductor.
3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; minimum size of 1-5/8 inches (42 mm) wide and 1/16 inch (1.5 mm) thick.

G. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.

2.3 CONNECTOR PRODUCTS

A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.

C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

2.4 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel.

1. Size: 5/8 by 120 inches.

PART 3 - EXECUTION

3.1 APPLICATION

A. Multiple Disconnecting Means Enclosures: Comply with NEC article 250.64(D).

B. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

C. In raceways, use insulated equipment grounding conductors.

D. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells.

E. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.

F. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Use insulated spacer; space 1 inch (25.4 mm) from wall and support from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.

G. Underground Grounding Conductors: Use copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches (600 mm) below grade or bury 12 inches (300 mm) above duct bank when installed as part of the duct bank.

3.2 EQUIPMENT GROUNDING CONDUCTORS

A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

B. Install equipment grounding conductors in all feeders and branch circuits.
1. Bond the grounding conductor to each pullbox, junction box, outlet box, cabinets, and other enclosure through which the ground conductor passes.

C. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 6 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch (6.4-by-50-by-300-mm) grounding bus.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.3 INSTALLATION

A. Ground Rods: Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.

1. Drive ground rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.
2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.

B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

C. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

D. Electrical Utility Service: Provide grounding and bonding at Utility Company's metering equipment and pad-mounted transformer in accordance with Utility Company's requirements.

E. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

F. Water Meter and Filter Piping: Use braided-type bonding jumpers to electrically bypass water meters, filters or other serviceable equipment. Connect to pipe with grounding clamp connectors.

G. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.

H. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.

I. Bond metal water piping systems in accordance with NEC Article 250.104.

J. Bond the grounding electrode system to the structural steel of building, if any, using exothermic weld. Coordinate work with the General Contractor.

K. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NEC Article 250, using a minimum of 20 feet (6 m) of bare copper conductor not smaller than No. 4 AWG. If concrete foundation is less than 20 feet (6 m) long, coil excess conductor within the base of the foundation. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to a grounding electrode external to concrete. Coordinate work with the General Contractor.

L. See grounding detail on the drawings.

3.4 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility 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 ensure high conductivity and to make contact points closer to order of galvanic series.
2. Make connections with clean, bare metal at points of contact. Remove all point from points of contact prior to making connections.
3. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded 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 Conductor 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. Noncontact Metal Raceway Terminations: If 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 noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

E. Tighten screws and bolts for grounding and bonding 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.

F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. 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: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.5 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

A. Pad-Mounted Transformers and Switches: Install four ground rods and counterpoise circling pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Use tinned-copper conductor not less than No. 1/O AWG (minimum) for counterpoise and for taps to equipment ground pad. Bury counterpoise not less than 18 inches (450 mm) below grade and 6 inches (150 mm) from the foundation. Coordinate with electrical utility requirements.

3.6 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:

1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two 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 fall-of-potential method according to IEEE 81.
3. Measure ground resistance from the system neutral connection at the service entrance to convenient ground reference point using suitable ground testing equipment. Resistance shall not exceed 5 ohms.
4. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

3.7 GRADING AND PLANTING

A. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If 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 application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with Division 32 Section "Turf and Grasses." Maintain restored surfaces. Restore disturbed paving as indicated.

END OF SECTION 260600

SECTION 261200 - 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. Product Data: For heat trace cables and controls.

B. Maintenance Data: For materials and products to include in maintenance manuals specified in Division 1.

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.

B. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver wires and cables according to NEMA WC 26.

1.6 COORDINATION

A. Coordinate layout and installation of cables with other installations.

B. Revise locations and elevations from those indicated, as required to suit field conditions and as approved by Architect.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Wires and Cables:

a. American Insulated Wire Corp.; Leviton Manufacturing Co.
b. BICC Brand-Rex Company.
c. Carol Cable Co., Inc.
d. Senator Wire & Cable Company.
e. Southwire Company.

2. Connectors for Wires and Cables:

a. AMP Incorporated.
b. General Signal; O-Z/Gedney Unit.
c. Square D Co.; Anderson.
d. 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 "Wire and Insulation Applications" Article.

B. Thermoplastic Insulation Material: Comply with NEMA WC-70 (ICEA S-95-658).

C. Cross-Linked Polyethylene Insulation Material: Comply with NEMA WC-70 (ICEA S-95-658).

D. Ethylene Propylene Rubber Insulation Material: Comply with NEMA WC-70 (ICEA S-95-658).

E. Conductor Material: Copper.

F. Stranding: Solid conductor for No. 12 AWG and smaller; stranded conductor for No. 8 AWG and larger. No. 10 AWG to be either solid or stranded (contractor’s option).

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 "Wire and Insulation Applications" Article.

B. All branch circuit wiring connections shall be made using wire nut connectors which provide direct wire to wire contact. Connectors which utilize insulation displacement, intermediate metal or spring compression connection are not acceptable.

2.4 HEAT TRACE CABLES

A. Provide UL listed heat trace cable for all exterior exposed water pipes to the chiller. Heating cables shall be equal to Raychem XL-Trace Self-Regulating Heating Cable, 8 watts per foot, powered by 120VAC and adjust it’s power along piping as required with the use of a Raychem

C910 controller. The system shall include all necessary components, including Raychem Rayclic PC power connection and Raychem Rayclic LE end of circuit light kits (verify pipe sizes with mechanical contractor).

1. The controller shall include internal ground-fault sensing, alarm, and trip functionality.
2. The heating cable shall consist of flat, flexible electric heater of parallel circuit construction with a continuous core of self-regulating polymer material. The core shall be insulated with fluoro-polymer over-jacked and covered with metal braid shield. The cable shall be cut to length in the field. Fasten linearly installed cable to pipe inside insulation with Raychem GT-66 fiberglass tape at 12" intervals. Valves shall have cable spiraled around each side of the valve. Install manufacturer furnished heat trace caution signs at 10' intervals.
3. Extended Warranty: Manufacturer shall provide a ten (10) year warranty for all heating cables and components. Provide one (1) year warranty for all heat trace controllers.
4. Contractor shall submit to owner results of installation tests as required by the manufacturer.
5. Equal products by Bylin, Delta Therm, Pyrotenax, and Thermon shall be considered equal for bidding purposes.

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.

3.2 WIRE AND INSULATION APPLICATIONS

A. Service Entrance: Type XHHW or THWN, in raceway.

B. Feeders: Type THHN/THWN, in raceway.

C. Branch Circuits: Type THHN/THWN, in raceway.

D. Branch Circuits: Type MC, 90C insulation, steel corrugated sheath. Only allowed for light fixture whips and fishing down existing walls.

E. Fire Alarm Circuits: Power-limited, fire-protective, signaling circuit cable, in raceway.

F. Fire Alarm Circuits: Type THHN/THWN, in raceway.

G. Class 1 Control Circuits: Type THHN/THWN, in raceway.

H. Class 2 Control Circuits: Power-limited cable, concealed in building finishes or in raceway where installed exposed in finished public spaces.

I. Class 2 Control Circuits: Type THHN/THWN, in raceway.

3.3 INSTALLATION

A. Install wires and cables as indicated, according to manufacturer's written instructions and NECA's "Standard of Installation."

B. Remove existing wires from raceway before pulling in new wires and cables.

C. Unless otherwise noted or shown on the drawings, a maximum of three circuits (three phase conductors, neutrals, and ground) shall be allowed in a single home run raceway.

D. Multiwire Branch Circuits: Sharing of neutrals is not allowed, provided dedicated neutral for each branch circuit.

E. Rooftop Circuits: Where conduits are installed exposed on rooftops, apply additional temperature adjustments listed in the NEC table 310.15(B)(2)(c) to ambient temperature correction factors listed in NEC table 310.16.

F. Wire size on 120 volt, 20 ampere branch circuit home run conductors over 75 feet in length (from the closest wiring device at the home run designation to the associated panelboard shown on the electrical drawing sheets), shall be increased to No. 10 AWG (minimum) to limit excessive voltage drop.

G. All corridor lighting branch circuits shall be increased to No. 10 AWG (minimum) through-out to limit excessive voltage drop.

H. All exterior lighting branch circuits shall be increased to No. 10 AWG (minimum) through-out to limit excessive voltage drop.

I. All lighting branch circuit home run conductors shall be increased to No. 10 AWG (minimum) (from the last light fixture at the home run designation shown on the electrical drawing sheets to the associated panelboard) to limit excessive voltage drop.

J. Pull Conductors: Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

K. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

L. Install exposed cables, parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

M. Support cables according to Division 26 Section "Basic Electrical Materials and Methods."

N. Seal around cables penetrating fire-rated elements according to 260500 and Division 7 Section "Firestopping."

O. Identify wires and cables according to Division 26 Section "Basic Electrical Materials and Methods."

3.4 CONNECTIONS

A. Conductor Splices: Keep to minimum.

B. Install splices and tapes that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.

C. Use splice and tap connectors compatible with conductor material.

D. Wiring at Outlets: Install pigtail conductor at each outlet, with at least 8 inches of slack. Where multiple sets of conductors enter a box, provide 8” pigtails to devices and make connections such that the continuity of the branch circuit conductors is not dependent upon device connections and the continuing load is not routed through the device. All unused device terminal screws shall be turned completely in, provide two full wraps of electrical tape around all device terminals. On 20 amp circuits where #10 AWG conductors are required for home runs, provide #12 AWG solid pigtails for connection to device.

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.

3.5 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 test stated in NETA ATS, Section 7.3.

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.

END OF SECTION 261200

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SECTION 261300 - 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.

1.3 SUBMITTALS

A. Product Data: For surface multi-outlet assembly raceways and floor boxes.

1.4 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.

1.5 COORDINATION

A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

B. Electrical Contractor shall furnish and install embedded electrical conduit, electrical box assemblies, and required hardware into the precast wall panels. The Electrical Contractor will provide locations on the precast shop drawing submittal and tradesmen in the precast production plant for this scope of work. Precast Supplier will provide coordination and production schedule with dates for each individual panel requiring electrical so the Electrical Contractor can schedule their workforce accordingly.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

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

1. AFC Cable Systems, Inc.
2. Alflex Inc.
3. Anamet Electrical, Inc.; Anaconda Metal Hose.
4. Electri-Flex Co.
5. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
6. LTV Steel Tubular Products Company.
7. Manhattan/CDT/Cole-Flex.
8. O-Z Gedney; Unit of General Signal.
9. Shamrock Steel.
10. Wheatland Tube Co.

B. Rigid Steel Conduit: ANSI C80.1.

C. IMC: ANSI C80.6.

D. PVC Coated Rigid Steel Conduit: NEMA RN 1.

E. EMT and Fittings: ANSI C80.3.

1. Fittings: Steel, set-screw or compression type with insulated bushings for protection of conductors. Diecast fittings are not approved.

F. FMC: Zinc-coated steel.

G. LFMC: Flexible steel conduit with PVC jacket.

2.2 NONMETALLIC CONDUIT AND TUBING

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

1. American International.
2. Anamet Electrical, Inc.; Anaconda Metal Hose.
3. Arnco Corp.
4. Cantex Inc.
5. Certainteed Corp.; Pipe & Plastics Group.
6. Condux International.
7. ElecSYS, Inc.
8. Electri-Flex Co.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT/Cole-Flex.
11. RACO; Division of Hubbell, Inc.
12. Spiralduct, Inc./AFC Cable Systems, Inc.
13. Thomas & Betts Corporation.

B. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.

C. RNC Fittings: NEMA TC 3; match to conduit or tubing type and material.

D. LFNC: UL 1660.

2.3 METAL WIREWAYS

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

1. Hoffman.
2. Square D.
3. Mono Systems, Inc.

B. Material and Construction: Sheet metal sized and shaped as indicated, NEMA [**1**] [**3R**].

C. 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.

D. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

E. Wireway Covers: Screw-cover type.

F. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Airey-Thompson Sentinel Lighting; Wiremold Company (The).
b. Thomas & Betts Corporation.
c. Mono-Systems, Inc.
d. Walker Systems, Inc.; Wiremold Company (The).
e. Wiremold Company (The); Electrical Sales Division.

B. Surface Nonmetallic Raceways (Multi-Outlet Assemblies): Two-piece construction, manufactured of rigid PVC compound with matte texture and manufacturer's standard color. See detail on drawings.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Butler Manufacturing Co.; Walker Division.
b. Enduro Composite Systems.
c. Hubbell, Inc.; Wiring Device Division.
d. Lamson & Sessions; Carlon Electrical Products.
e. Mono Systems, Inc.
f. Panduit Corp.
g. Walker Systems, Inc.; Wiremold Company (The).
h. Wiremold Company (The); Electrical Sales Division.

C. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

2.5 BOXES, ENCLOSURES, AND CABINETS

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

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. Emerson/General Signal; Appleton Electric Company.
3. Erickson Electrical Equipment Co.
4. Hoffman.
5. Hubbell, Inc.; Killark Electric Manufacturing Co.
6. O-Z/Gedney; Unit of General Signal.
7. RACO; Division of Hubbell, Inc.
8. Robroy Industries, Inc.; Enclosure Division.
9. Scott Fetzer Co.; Adalet-PLM Division.
10. Spring City Electrical Manufacturing Co.
11. Thomas & Betts Corporation.
12. Walker Systems, Inc.; Wiremold Company (The).
13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

B. Outlet boxes shall be galvanized steel standard electrical type with knockout openings as required.

C. Outlet boxes shall be at least 1-1/2” deep, single or gang style type of sized to accommodate devices noted. Outlet boxes in masonry walls may be special masonry type. Outlet boxes on exposed conduit runs in unfinished areas and equipment rooms shall be 4” square or multi-gang boxes with matching raised covers. Outlet boxes on exposed conduit runs in finished areas or where indicated, shall be cast FS type.
1. Outlet boxes for communications outlets shall be a minimum of 2-1/8” deep.

D. Exterior outlet boxes shall be cast aluminum type with weatherproof cover and gasket. Outlet boxes for receptacle devices shall be provided with grounding lead lug or screw.

E. Outlet boxes installed in plaster, plasterboard, acoustic tile, or paneled surfaces shall be provided with plaster rings, except 4” octagonal ceiling boxes. Outlet boxes installed in masonry, tile, or concrete surfaces shall be provided with square corner type extension rings where special masonry boxes are not used.

F. Outlet boxes noted as WP (weatherproof) shall be a flush or surface (as noted) FS type box with at least 4 machine screw connections for a gasketed device or cover.

G. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

H. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.

I. Nonmetallic Outlet and Device Boxes: NEMA OS 2.

A. Floor Boxes (Two Devices): Floor boxes installed in tile or carpet floors shall be equal to Steel City 664 Series. Concealed service type, 2-compartment, steel construction with solid aluminum #664-CST-SW-ALM hinged floor plate and retractable exit port for power cords and

communications cables. Provide internal device mounting panels compatible with devices being installed. Provide wiring and communications devices as shown on the floor plans and specified.

B. Floor Boxes (Up to Four Devices): Floor boxes installed in tile or carpet floors shall be equal to Steel City 665 Series. Concealed service type, 4-compartment, steel construction with solid aluminum #665-CST-SW-ALM hinged floor plate and retractable exit port for power cords and communications cables. Provide internal device mounting panels compatible with devices being installed. Provide wiring and communications devices as shown on the floor plans and specified.

C. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

D. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.

E. Provide wall plates for all unused outlet and device boxes. Wall plates shall comply with section 261400.

F. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Provide backplate and grounding as required by the authority having jurisdiction for installation of indicated equipment.

G. 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.

2.6 FACTORY FINISHES

A. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard prime-coat finish ready for field painting.

B. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard color paint applied to factory-assembled surface raceways, enclosures, and cabinets before shipping.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. ENT – Electrical Non-metallic Tubing is not acceptable for use anywhere on this project.

B. Outdoors:

1. Exposed: Rigid steel or IMC.
2. Concealed: Rigid steel or IMC.
3. Underground, Single Run: RNC, see installation for additional requirements.
4. Underground, Grouped: RNC, see installation for additional requirements.

5. Underslab: RNC, see installation for additional requirements.
6. Embedded in slab: Rigid steel.
7. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
8. Boxes and Enclosures: NEMA 250, Type 3R.

C. Indoors:

1. Exposed: EMT.
2. Concealed: EMT.
3. Underslab: RNC, see installation for additional requirements.
4. Embedded in slab: Rigid steel.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except use LFMC in damp or wet locations.
6. Damp or Wet Locations: Rigid steel conduit.
7. Boxes and Enclosures: NEMA 250, Type 1, except as follows:

    a. Damp or Wet Locations: NEMA 250, Type 4, nonmetallic.

D. Minimum Raceway Size: ½-inch trade size (DN16), except home runs from the closest wiring device or light fixture at the home run designation to the associated panelboard shown on the electrical drawing sheets shall be ¾-inch (minimum) trade size (DN21).

E. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Intermediate Steel Conduit: Use threaded rigid steel conduit fittings with insulated bushings, unless otherwise indicated.
2. 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.

3.2 INSTALLATION

A. Install raceways, boxes, enclosures, and cabinets as indicated and in accordance to manufacturer’s written instruction.
1. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
2. Install raceways level and square and at proper elevations. Provide adequate headroom.
3. Complete raceway installation before starting conductor installation.
4. Support raceways as specified in Division 26 Section "Basic Electrical Materials and Methods."
5. Install temporary closures to prevent foreign matter from entering raceways.
6. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab. Install a metal sleeve or concrete curb to provide a 4 inch high watertight barrier.
7. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.
8. Metal-corrugated sheet roof decking: Install and support so that nearest outside surface of the raceway or box is not less than 1.5” from the nearest surface of the roof decking. In addition, cables, raceways, and enclosures shall not be installed in concealed locations of metal-corrugated sheet decking type roofing. Spacing from roof decking doesn’t apply to rigid metal conduit or intermediate metal conduit.

9. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
    a. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
10. Exterior raceways:
    a. Install a minimum 24 inches below grade.
    b. Where multiple conduit runs are indicated, they shall be installed in the same trench.
    c. Where raceways stub into sub-grade levels, utilize installation methods to prevent migration of water into the building interior spaces.
    d. All 90 degree ells must be rigid steel conduit.
    e. Transition to rigid steel conduit before the conduit is exposed.
    f. Metallic conduit exterior or within building limits, that is in contact with earth, shall be galvanized rigid conduit with factory applied vinyl plastic coating or galvanized rigid conduit painted with heavy coat of bitumastic paint. Couplings shall be painted after assembly. Nicks in plastic coated conduit shall be painted with plastic material as recommended by the manufacturer. Where bitumastic paint is applied, the paint must be thoroughly dry prior to backfilling.
    g. Provide warning tape in accordance with specification section 260500.
11. Raceways underground or under slabs:
    a. All 90 degree ells must be rigid steel conduit.
    b. Transition to rigid steel conduit before the conduit is exposed.
    c. Metallic conduit exterior or within building limits, that is in contact with earth, shall be galvanized rigid conduit with factory applied vinyl plastic coating or galvanized rigid conduit painted with heavy coat of bitumastic paint. Couplings shall be painted after assembly. Nicks in plastic coated conduit shall be painted with plastic material as recommended by the manufacturer. Where bitumastic paint is applied, the paint must be thoroughly dry prior to backfilling.
    d. Provide expansion fittings where conduits cross building expansion joints or where a wide temperature differential exists.
12. Raceways Embedded in Slabs: Install in middle 1/3 of slab thickness where practical and leave at least 1 inch (25 mm) of concrete cover.
    a. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
    b. Space raceways laterally to prevent voids in concrete.
    c. Run conduit larger than 1-inch trade size (DN 27) parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
    d. Provide expansion fittings where conduits cross building expansion joints or where a wide temperature differential exists.
13. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.
    a. Run parallel or banked raceways together on common supports.
    b. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
14. Outlet boxes shall be concealed except where shown or noted otherwise. Outlet boxes, plaster rings or extension rings shall be installed flush with the finished surface.
15. Where applicable, outlet boxes for controls and operating mechanisms shall be installed to comply with ADA mounting height requirements.
16. Junction and Pull Boxes

a. Where necessary to terminate, tap-off, or redirect multiple conduit runs, provide and install appropriately sized junction boxes. Furnish and install pull boxes where necessary in the raceway system to facilitate conductor installation. Provide pull boxes to limit conduit runs to less than 150 feet and to contain no more than the equivalent of three right angle bends.
b. Use outlet boxes as junction boxes and pull boxes wherever possible and allowed by applicable codes. Make all boxes accessible and do not install boxes in finished areas. Mount all boxes plumb and level. Use flush mounted boxes with concealed conduits and make edges of boxes flush with the final surface.
c. Install boxes supported independently of conduit by attachment to the building structure or a structural member.

17. Join raceways with fittings designed and approved for that purpose and make joints tight.
    a. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
    b. Use insulating bushings to protect conductors.
18. Tighten set screws of threadless fittings with suitable tools.
19. Terminations:
    a. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
    b. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.
20. Install pull wires in empty raceways. Use polypropylene 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 pull wire.
21. Telephone and Signal System Raceways for conduit cabling technique. 2-inch trade size (DN 53) and smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet (45 m) and with a maximum of three 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.
22. Telephone and Signal System Raceways for free air cabling technique. 2 Inch Trade Size (DN 53) and smaller. Provide minimum ¾ inch conduit from outlet box to 8 inches above accessible lay-in ceiling system, terminate with insulated bushing. Provide empty conduits, appropriately sized for the application, through floors and walls, above hard ceilings, and at exposed ceiling structure locations to provide clear and smooth pathways for cabling. Coordinate cable pathway requirements with data and voice cabling contractor.
23. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
    a. Service entrance conduits.
    b. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
    c. Where conduits enter or exit the building.
    d. Where otherwise required by NFPA 70.
24. 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 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 plugs flush with floor for future equipment connections.

25. Flexible Connections: Use maximum of 72 inches (48 inches in ducts and plenums) of flexible conduit for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.
26. Do not utilize aluminum conduit.
27. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.
    a. Select each surface raceway outlet box, to which a lighting fixture is attached, to be of sufficient diameter to provide a seat for the fixture canopy.
    b. Where a surface raceway is used to supply a fluorescent lighting fixture having central-stem suspension with a backplate and canopy (with or without extension ring), no separate outlet box is required.
    c. Provide surface metal raceway outlet box, backplate, and canopy at the feed-in location of each fluorescent lighting fixture having end-stem suspension.
    d. Where a surface metal raceway extension is made from an existing outlet box on which a lighting fixture is installed, no additional surface-mounted outlet box is required. Provide a backplate slightly smaller than the fixture canopy.
28. Set floor boxes level and flush with finished floor surface.
29. Install hinged-cover enclosures and cabinets plumb. Support at each corner.
30. Direct Buried Conduit Backfill: Comply with Division 2 requirements.

B. Location of Outlets and Equipment.
1. Outlets shall be installed at the heights and approximate designated positions as shown on the Drawings and symbol legend, unless otherwise directed. Outlets in similar rooms shall be installed in the same relative location in each room. Outlets shall not be installed back to back but shall be offset approximately 6 inches.
2. Outlets shall be located to clear piping, ductwork, and other obstructions. Switch outlets shall be on the latch side of door except where type of construction dictates otherwise. Outlets in masonry or tile shall be located as far as practical adjacent to horizontal and vertical mortar joints to minimize cutting.
3. Verify locations and dimensions of electrical equipment, particularly in the case of door swings, heights of cabinets and counters, shelves, and location of equipment installed by the Owner or other trades.
4. Mounting heights indicated on the drawings shall be to center line of outlet unless indicated otherwise. Heights may be adjusted to align with mortar joints as specified above, however, all similar outlets in a given area shall be adjusted to the same height unless specifically noted at the outlet.
5. Receptacle outlets indicated to be installed “A.C.” (above counter) shall be mounted not less than 3 inches higher than the top of the counter backsplash or at heights indicated.
6. All similar equipment such as panelboards, motor starters, disconnect switches, etc., shall be installed at the same heights throughout the building.

3.3 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.4 CLEANING

A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION 261300

SECTION 261400 - 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 receptacles, connectors, switches, and finish plates.

1.3 SUBMITTALS

A. Product Data: For each product specified.

B. Maintenance Data: For materials and products to include in maintenance manuals specified in Division 1.

1.4 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 NEMA WD 1.

C. Comply with NFPA 70.

1.5 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. 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. Multioutlet Assemblies:

a. Airey-Thompson Co.
b. Mono Systems, Inc.
c. Wiremold.
d. Panduit.

3. Poke-through, Floor Service Outlets and Telephone/Power Poles:

a. American Electric.
b. Hubbell, Inc.; Wiring Devices Div.
c. Mono Systems, Inc.
d. Pass & Seymour/Legrand; Wiring Devices Div.
e. Square D Co.
f. Wiremold.

2.2 RECEPTACLES

A. Straight-Blade and Locking Receptacles: Hard use (heavy duty) specification grade, minimum 20A rating, side wired.

B. Tamper Resistant Straight-Blade Receptacles: Specification grade, hard-use, minimum 20A rating, side wired, with either internal sliding-shutter barrier system requiring the presence of an object on both sides of the shutter to allow access to contacts or internal switching requiring the presence of an object in both contacts to energize the device.

C. Ranges and Clothes Dryers: Receptacles for ranges and clothes dryers shall be 3 pole, 4 wire grounding type.

D. GFCI Receptacles: Feed-through type, with integral NEMA WD 6, Configuration 5-20R duplex receptacle arranged to protect connected downstream receptacles on same circuit. Design units for installation in a 2-3/4-inch- (70-mm-) deep outlet box without an adapter.

2.3 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.

2.4 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.

2.5 SWITCHES

A. Snap Switches: Heavy-duty, quiet type, 20 amp, 120-277 volt – AC, with back and side wired screw terminals; Pass & Seymour PS20AC-1 or equal. Single-pole or three-way to suit connections.

2.6 WALL PLATES

A. Single and combination types match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: 0.04-inch- (1-mm-) thick, Type 302, satin-finished stainless steel.
3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Wet Locations: Heavy duty die-cast zinc.
    a. Where required by the authority having jurisdiction, receptacle covers shall be “While in Use”, “Extra-Duty” type, equal to Intermatic WP3110MXD, or WP1030MXD, or WP1010HMXD series, consisting of heavy duty die cast construction with lockable hasp.

2.7 FLOOR SERVICE FITTINGS

A. Floor Boxes: See Specification Section 261300.

B. Power Receptacle: NEMA WD 6, Configuration 5-20R, gray finish, unless otherwise indicated.

C. Signal Outlet: Standard receptacle plate compatible with service unit and phone/data adapter to fit plate.

2.8 MULTIOUTLET ASSEMBLIES

A. Components of Assemblies (See detail on drawings): Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

B. Raceway Material: Nonmetal.

C. Wire: No. 12 AWG.

2.9 WIRING DEVICE FINISHES

A. Color: Gray, unless otherwise indicated or required by Code.

2.10 ELECTRIC HAND DRYERS

A. Electric hand dryers shall be Extreme Air model #EXT7-SS with ADA-RK recess kit, vandal resistant, ADA compliant, sensor operated, stainless steel finish.
   1. Coordinate mounting height with architect.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Switches shall be installed so that the handle is down when the switch in the off position.

B. Receptacle and switch branch circuit wiring shall be terminated on the side wired screw terminals.

C. In storage, mechanical, and electrical equipment rooms where the receptacle is located adjacent to the light switch at 46” AFF, the devices shall be installed in a combination cover-plate and back-box assembly.

D. GFI Receptacles: Ground fault circuit-interruption for personnel shall be provided as required in the NEC 210.8(A) through (C). The ground-fault circuit-interruper shall be installed in a readily accessible location.

E. Wet Locations: All 15- and 20-ampere 125- and 250-volt nonlocking receptacles shall be listed weather-resistant type.

F. Install devices and assemblies level, plumb, and secure.

G. Where applicable, devices for controls and operating mechanisms shall be installed to comply with ADA mounting height requirements.

H. Provide tamper resistant receptacles in pediatric care areas of health care facilities, areas within dwelling units as required by the NEC articles 210.52 and 406.12, guest rooms and guest suites, child care facilities, and other areas as indicated on the drawings.
   1. Contractor shall note NEC article 406.2, definition of child care facility and verify with the AHJ areas of the facility requiring tamper resistant receptacles.

I. Install wall plates when painting is complete.

J. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical. Group adjacent switches under single, multigang wall plates.
   1. Exterior receptacles shall be installed with long dimension horizontal, mounting height of approximately 25” above finish grade.

K. Orientation of Receptacles: Install with grounding terminal of receptacles on the top.

L. Protect devices and assemblies during painting.

M. Adjust locations at which floor service outlets are installed to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Basic Electrical Materials and Methods."
   1. Receptacles: Identify panelboard and circuit number from which served. Use durable wire markers or tags within outlet boxes.
   2. Where receptacles are supplied through a GFCI breaker or connected “downstream” of a GFCI receptacle, the receptacle shall be marked “GFCI Protected”.

3.3 CONNECTIONS

A. Connect wiring device grounding terminal to branch-circuit equipment grounding conductor.

B. 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.

C. Where multiple sets of conductors terminate at a box, provide pigtails to devices such that the continuity of the branch circuit conductors is not dependent upon device connections and the continuing load is not routed through the device. See section 261200 – Conductors and Cables.

3.4 FIELD QUALITY CONTROL

A. Test wiring devices for proper operation, polarity and ground continuity.

B. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.

C. Replace damaged or defective components.

3.5 CLEANING

A. Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION 261400

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SECTION 261450 - 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 photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 SUBMITTALS

A. Product Data: Include dimensions and data on features, components, and ratings for lighting control devices.

B. Maintenance Data: For lighting control devices to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

A. 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.

B. Comply with 47 CFR 15, Subparts A and B, for Class A digital devices.

C. Comply with NFPA 70.

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 26 Section "Panelboards."
   2. Division 26 Section “Interior Lighting.”
   3. Division 26 Section “Exterior Lighting.”

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Contactors and Relays:
      a. Automatic Switch Co.
      b. Cutler-Hammer Products; Eaton Corporation.
      c. Furnas Electric Co.
      d. GE Lighting Controls.
      e. Hubbell Lighting, Inc.
      f. Siemens Energy and Automation, Inc.
      g. Square D Co.; Power Management Organization.
   2. Photoelectric Relays:
      a. Allen-Bradley/Rockwell Automation.
      b. Area Lighting Research, Inc.
      c. Intermatic, Inc.
      d. Paragon Electric Co., Inc.
      e. Tork, Inc.
   3. Occupancy Sensors:
      a. Arrow Hart Wiring Devices
      b. GE Lighting Controls
      c. Hubbell Lighting, Inc.
      d. Leviton Lighting Controls
      e. Lightolier
      f. MYTECH
      g. Sterner Lighting Systems, Inc.
      h. Tork, Inc.
      i. Touchplate.
      j. Watt Stopper, Inc.

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 PHOTOELECTRIC RELAYS

A. Description: Contacts rated to operate connected relay or contactor coils or microprocessor input, and complying with UL 773A.

B. Light-Level Monitoring Range: 0 to 500 fc, with an adjustment for turn-on/turn-off levels.

C. Fail mode shall be on.

D. Time Delay: Prevents false operation.

E. Outdoor Sealed Units: Weathertight housing, resistant to high temperatures and equipped with sun-glare shield and ice preventer.

2.4 OCCUPANCY SENSORS

A. Operation: Turns lights on when room or covered area is occupied and off when unoccupied, unless otherwise indicated.

1. Time Delay for Turning Lights Off: Adjustable over a range from 3 to 30 minutes, minimum.
2. Self-Adjusting Technology: Monitor the controlled area and automatically make self-adjustments for everday use.
3. Occupancy sensors shall be equal to WattStopper UT-355-1 ultrasonic line voltage type, 120V.

2.5 MULTIPOLE CONTACTORS AND RELAYS

A. Description: Electrically operated and electrically 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.

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 26 Section "Basic Electrical Materials and Methods."

C. Mounting heights indicated are to bottom of unit for suspended devices and to center of unit for wall-mounting devices.

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 and Division 26 Section "Voice and Data Systems" for digital circuits.

B. Wiring Method: Install all wiring in raceway as specified in Division 26 Section "Raceways and Boxes."

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.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Basic Electrical Materials and Methods."

B. Lighting Control Enclosure Nameplates: Label each lighting control panel and contactor with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.4 FIELD QUALITY CONTROL

A. Inspect control components for defects and physical damage, testing laboratory labeling, and nameplate compliance with the Contract Documents.

B. Check tightness of electrical connections with torque wrench calibrated within previous six months. Use manufacturer's recommended torque values.

C. 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.

    a. Include testing of devices under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.

D. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.

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. 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 two hours' training.
2. Training Aid: Use the approved final version of maintenance manuals as a training aid.
3. Schedule training with Owner, through Architect, 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 two Project site visits, when requested, to adjust light levels and adjust sensors and controls to suit actual conditions.

END OF SECTION 261450

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SECTION 264100 - ENCLOSED SWITCHES

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 enclosed switches used for the following:
   1. Motor and equipment disconnecting means.

1.3 SUBMITTALS

A. Product Data: For each type of switch, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each switch.

   1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

      a. Mark each product data sheet with the tag number and equipment description indicated on the mechanical equipment schedule and/or power riser diagram.
      b. Enclosure types and details for types other than NEMA 250, Type 1.
      c. Current and voltage ratings.
      d. Short-circuit current rating.
      e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

   2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.

C. Maintenance Data: For enclosed switches and for components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section "Closeout Procedures," include the following:

   1. Routine maintenance requirements for components.

1.4 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 NEMA AB 1 and NEMA KS 1.

C. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate layout and installation of switches and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate features, accessories, and functions of each enclosed switch with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Fusible and Nonfusible Switches:

    a. Eaton Corp.; Cutler-Hammer Products.
    b. General Electric Co.; Electrical Distribution & Control Division.
    c. Siemens Energy & Automation, Inc.
    d. Square D Co.

2.2 ENCLOSED SWITCHES

A. Enclosed, Nonfusible Switch: NEMA KS 1, Type HD, with lockable handle.

B. Enclosed, Fusible Switch, 1600 A and Smaller: NEMA KS 1, Type HD, with clips to accommodate specified fuses, lockable handle, and interlocked with cover in closed position.

2.3 ENCLOSURES

A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.

1. Outdoor Locations: NEMA 250, Type 3R.
2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.

2.4 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosures before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches for compliance with installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install enclosed switches in locations as indicated, according to manufacturer’s written instructions. Verify that the installation will be readily accessible and will provide the clearances as required by the NEC article 110-26.

B. Exterior Enclosures: Mount enclosures at elevations to maximize aesthetics and minimize viewing angles by the public.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Basic Electrical Materials and Methods."

B. Enclosure Nameplates: Label each enclosed switch with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws. Label shall indicate the equipment being served.

3.4 CONNECTIONS

A. Install equipment grounding connections for switches with ground continuity to main electrical ground bus.

B. Install power wiring. Install wiring between switches and control and indication devices.

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
1. Test continuity of each line- and load-side circuit.

B. Testing: After installing enclosed switches and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection test indicated in NETA ATS, Section 7.5 for switches.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.6 CLEANING

A. On completion of installation, inspect interior and exterior of enclosures. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 264100

SECTION 264200 - ENCLOSED CONTROLLERS

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 ac general-purpose controllers rated 600 V and less that are supplied as enclosed units.

1.3 SUBMITTALS

A. Product Data: For each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.

1. Mark each product data sheet with the tag number and description indicated on the mechanical equipment schedule.

B. Maintenance Data: For enclosed controllers and components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section "Closeout Procedures," include the following:

1. Routine maintenance requirements for enclosed controllers and all installed components.

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.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain, within 150 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.

C. 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.

D. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.6 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.

C. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

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.
   1. Indicating Lights: Two of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

   1. Manual and Magnetic Enclosed Controllers:

      a. Eaton Corp.; Cutler-Hammer Products.
      b. General Electrical Distribution & Control.
      c. Rockwell Automation Allen-Bradley Co.; Industrial Control Group.
      d. Siemens/Furnas Controls.
      e. Square D Co.

2.2 MAGNETIC ENCLOSED CONTROLLERS

A. Description: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.

B. Control Circuit: 120 V; obtained from integral control power transformer with secondary fuse protection. The control power transformer shall have sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.

C. Combination Controller: Factory-assembled combination controller and disconnect switch.
   1. Nonfusible Disconnecting Means: NEMA KS 1, heavy-duty, nonfusible switch.

D. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 10 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.

E. Adjustable Overload Relay (shall be provided for all starters associated with 3 phase motors rated at 5HP or larger): Solid state, 3 to 1 adjustment for trip current, and protect motor against voltage and current unbalance and phase loss.

2.3 ENCLOSURES

A. Description: Flush- or surface-mounted cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.

2.4 MANUAL MOTOR CONTROLLERS

A. Fractional Horsepower Manual Starters: NEMA ICS 2; AC general purpose Class A manually operated, 1 or 2 pole, full-voltage controller rated for 1 horsepower, with adjustable one-piece melting alloy type thermal overload unit rated for connected load, and toggle operator, suitable for flush mounting in finished spaces. NEMA 3R lockable controller for exterior locations.

2.5 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

C. Furnish each controller with red-run and green-off LED type indicating lights, 2 auxiliary M contacts.

D. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

2.6 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosed controllers before shipping.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Select features of each enclosed 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. Use manual controllers for 3-phase motors up to 5 horsepower not requiring automatic or remote control.

E. Push-Button Stations: In covers of magnetic controllers for manually started motors where indicated, start contact connected in parallel with sealing auxiliary contact for low-voltage protection.

F. Hand-Off-Automatic Selector Switches: Provide in covers of manual and magnetic controllers of motors started and stopped by automatic controls or interlocks with other equipment.

3.2 INSTALLATION

A. Install enclosed controllers in locations as indicated, according to manufacturer's written instructions. Verify that the installation will be readily accessible and will provide the clearances as required by the NEC article 110-26.

B. See Division 26 Section "Basic Electrical Materials and Methods" for general installation requirements.

C. Install independently mounted control devices according to manufacturer's written instructions.

D. Locate controllers within sight of motors controlled, unless otherwise indicated.

E. 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 complying with Division 26 Section "Basic Electrical Materials and Methods."

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Basic Electrical Materials and Methods."

B. Enclosure Nameplates: Label each enclosed controller with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws. Label shall indicate the equipment being served.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers according to Division 26 Section "Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.

1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.

2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

3.6 FIELD QUALITY CONTROL

A. Testing: After installing controllers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements. Perform the following field quality-control testing:

1. Perform each visual and mechanical inspection indicated in NETA ATS, Sections 7.5, 7.6, and 7.16.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.7 CLEANING

A. Clean enclosed controllers internally, on completion of installation, according to manufacturer's written instructions. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

B. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

3.8 STARTUP SERVICE

A. Verify that enclosed controllers are installed and connected according to the Contract Documents.

B. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 26 Sections.

C. Complete installation and startup checks according to manufacturer's written instructions.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers.

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
2. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION 264200

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SECTION 264410 - 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. This Section includes service and distribution switchboards rated 600 V and less.

1. Main Switchboard “MSB”, 1600A bus, 208Y/120V, 3 phase, 4 wire.
2. For the existing main switchboard “MSB” at Madison Elementary School, all circuit breakers shall be consider main circuit breakers.
3. The new main switchboard “MSB” at Washington Elementary School shall be provided with a 1600A main circuit breaker.

1.3 SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each switchboard and related equipment.

1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Enclosure types and details for types other than NEMA 250, Type 1.
b. Bus configuration, current, and voltage ratings.
c. Short-circuit current rating of switchboards and overcurrent protective devices.
d. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

C. Maintenance Data: For switchboards and components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section "Contract Closeout," include the following:

1. Routine maintenance requirements for switchboards and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
3. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.4 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 NEMA PB 2.

C. Comply with NFPA 70.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards, including clearances between switchboards, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver in sections of lengths that can be moved past obstructions in delivery path.

B. Store indoors in clean dry space with uniform temperature to prevent condensation. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.

C. If stored in areas subjected to weather, cover switchboards to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchboards; install electric heating (250-W per section) to prevent condensation.

D. Handle switchboards according to NEMA PB 2.1.

1.6 PROJECT CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. 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 not less than seven days in advance of proposed utility interruptions. Identify extent and duration of utility interruptions.
2. Indicate method of providing temporary utilities.
3. Proceed with utility interruptions only after receiving Architect's written authorizations.

1.7 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."

PART 2 - PRODUCT

2.1 MANUFACTURERS

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

1. Eaton Corp.; Cutler-Hammer Products.
2. General Electric Co.; Electrical Distribution & Control Div.
3. Siemens Energy & Automation, Inc.
4. Square D Co.

2.2 MANUFACTURED UNITS

A. Front-Connected, Front-Accessible Switchboard: Fixed, individually mounted main device, panel-mounted branches, and sections rear aligned.

1. Main Devices: Fixed, individually mounted.
2. Branch Devices: Panel mounted.

B. Nominal System Voltage: 208 Y/120 V.

C. Main-Bus Continuous: 1600 A.

2.3 FABRICATION AND FEATURES

A. Enclosure: Steel: NEMA 250, Type 3R.

B. Enclosure Finish for Outdoor Units: Factory-applied finish in manufacturer's standard color, including undersurfaces treated with corrosion-resistant undercoating.

C. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

D. Hinged Front Panels: Allow access to circuit-breaker, metering, accessory, and blank compartments.

E. Buses and Connections: Three phase, four wire, unless otherwise indicated. Include the following features:

1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity with feeder circuit-breaker line connections.
   a. If bus is copper, use copper for feeder circuit-breaker line connections.
2. Phase- and Neutral-Bus Material: Tin-plated, high-strength, electrical-grade aluminum alloy with copper or tin-plated, aluminum circuit-breaker line connections.
   a. If bus is aluminum, use copper or tin-plated aluminum for circuit-breaker line connections.
3. Ground Bus: 1/4-by-2-inch (6-by-50-mm) minimum size, drawn-temper copper of 98 percent conductivity, equipped with pressure connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

4. Contact Surfaces of Buses: Silver plated.
5. Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
6. Neutral Buses: 100 percent of the ampacity of the phase buses, unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables. Bus extensions for busway feeder neutral bus is braced.

F. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.4 SWITCHBOARD SHORT-CIRCUIT RATING

A. Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.5 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. 100% Rated Electronic Trip Unit Main Circuit Breaker (For Main Switchboard “MSB”): RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
    d. A qualified manufacturer’s representative shall set circuit breaker settings in the field.

B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Mechanical style, suitable for number, size, trip ratings, and material of conductors.
2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.

PART 3 - EXECUTION

3.1 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.2 EXAMINATION

A. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1.

B. Support switchboards on concrete 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.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Basic Electrical Materials and Methods."

B. Switchboard Nameplates: Label each switchboard section and overcurrent protection device (OCPD) with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws. Each switchboard section label shall indicate switchboard name, section, voltage and phase, and where the switchboard is fed from. Each OCPD label shall indicate the device being protected.

3.5 CONNECTIONS

A. Install equipment grounding connections for switchboards with ground continuity to main electrical ground bus.

B. 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.

3.6 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
1. Test continuity of each circuit.

B. 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 test indicated in NETA ATS, Sections 7.1, 7.5, 7.6, 7.9, 7.10, 7.11, and 7.14 as appropriate.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.7 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.8 CLEANING

A. On completion of installation, inspect interior and exterior of switchboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 264410

SECTION 264420 - PANELBOARDS

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 load centers and panelboards, overcurrent protective devices, and associated auxiliary equipment rated 600 V and less for the following types:

1. Lighting and appliance branch-circuit panelboards.
2. Distribution panelboards.

1.3 SUBMITTALS

A. Product Data: For each type of panelboard, overcurrent protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Enclosure types and details for types other than NEMA 250, Type 1.
b. Bus configuration, current, and voltage ratings.
c. Short-circuit current rating of panelboards and overcurrent protective devices.
d. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Wiring Diagrams: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.

C. Maintenance Data: For panelboards and components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section "Contract Closeout," include the following:
1. Panelboard Schedules: For installation in panelboards. Submit final versions.
a. Copies of panelboard schedules shall be provided in the operation and maintenance manuals in case circuit directories in the panelboards are lost.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
3. Time-current curves, including selectable ranges for each type of overcurrent protective device.

D. Panelboard Overcurrent Protection Device Arrangement: To the extent possible, coordinate with panelboard supplier for correct arrangement of overcurrent protection devices (OCPD's) within panelboards to match panelboard schedules shown on the electrical drawings. The contractor shall rearrange OCPD's if necessary to match the schedules shown on the electrical drawings.

1.4 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 NEMA PB 1.

C. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

1.6 EXTRA MATERIALS

A. Keys: Four spares of each type of panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:

    a. Eaton Corp.; Cutler-Hammer Products.
    b. General Electric Co.; Electrical Distribution & Control Div.
    c. Schneider Electric (Square D Co.)
    d. Siemens Energy & Automation, Inc.

2.2 FABRICATION AND FEATURES

A. Enclosures: Flush- and surface-mounted cabinets. NEMA PB 1, Type 1, to meet environmental conditions at installed location.

B. Covers:

1. Provide hinged front trim cover with front trim hinged to box with standard circuit breaker access door within hinged trim cover. Provide flush latch with tumbler lock for circuit breaker access door.

C. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.

D. Directory Card: With transparent protective cover, mounted inside metal frame, inside panelboard door.

E. Bus: Hard-drawn copper, 98 percent conductivity.

F. Main and Neutral Lugs: Mechanical type suitable for use with conductor material.

G. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.

H. Service Equipment Label: UL labeled for use as service equipment for panelboards with main service disconnect switches.

I. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

J. Feed-through Lugs: Mechanical type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

2.3 PANELBOARD SHORT-CIRCUIT RATING

A. Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

2.5 DISTRIBUTION PANELBOARDS

A. Doors: Front mounted, except omit in fused-switch panelboards; secured with vault-type latch with tumbler lock; keyed alike.

B. Main Overcurrent Protective Devices: Circuit breaker.

C. Branch overcurrent protective devices shall be one of the following:

1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.6 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. 100% Rated Electronic Trip Unit Main Circuit Breaker (For Main Circuit Breaker in Panel "MDP" and "MDPM"): RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments.
3. GFCI Circuit Breakers for Personnel Protection: Single- and two-pole configurations with 5-mA trip sensitivity.
4. GFCI Circuit Breakers for Equipment Protection: Single- and two-pole configurations with 30-mA trip sensitivity.

B. Molded-Case Circuit-Breaker Features and Accessories. Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Mechanical style, suitable for number, size, trip ratings, and material of conductors.
2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
3. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.

2.7 INSTRUMENTATION

A. Distribution Panel "DPB" (Madison Elementary) shall be provided with customer metering in accordance with the following:
1. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
   a. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
      1) Phase Currents, Each Phase: Plus or minus 1 percent.
      2) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
      3) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
      4) Megawatts: Plus or minus 2 percent.
      5) Megavars: Plus or minus 2 percent.
      6) Power Factor: Plus or minus 2 percent.
      7) Frequency: Plus or minus 0.5 percent.
      8) Megawatt Demand: Plus or minus 2 percent; demand interval programmable from 5 to 60 minutes.
      9) Accumulated Energy, Megawatt Hours: Plus or minus 2 percent. Accumulated values unaffected by power outages up to 72 hours.
   b. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Mounting Heights: Top of trim 74 inches (1880 mm) above finished floor, unless otherwise indicated.

C. Mounting: Surface mount panelboards shall be mounted to ¾" plywood backboards. Paint backboards with two coats of grey fire retardant paint.

D. Mounting: Plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

E. Circuit Directory: Create a directory to indicate installed circuit loads. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
   1. Room names or Owner's room numbers shall be used. Do not use plan room numbers unless approved by the owner.
   2. Spare circuit breakers shall be identified as such.

F. Install filler plates in unused spaces.

G. Provision for Future Circuits at Flush Panelboards: Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.

H. Wiring in Panelboard Gutters: Arrange conductors into groups and bundle and wrap with wire ties after completing load balancing.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Basic Electrical Materials and Methods."

B. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.
   1. Lighting and Appliance Panelboards: Each lighting and appliance panelboard label shall indicate the panelboard name, voltage and phase, and where the panel is fed from.
   2. Distribution Panelboards: Label each distribution panelboard section and overcurrent protection device (OCPD). Each section label shall indicate distribution panelboard name, section, voltage and phase, and where the panel is fed from. Each OCPD label shall indicate the device being protected.

3.3 CONNECTIONS

A. Install equipment grounding connections for panelboards with ground continuity to main electrical ground bus.

B. 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.

3.4 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
   1. Test continuity of each circuit.

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 test indicated in NETA ATS Section 7.6 for molded-case circuit breakers.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.5 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.6 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 264420

SECTION 264910 - 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 cartridge fuses, rated 600 V and less, for use in switches.

1.3 SUBMITTALS

A. Product Data: Include the following for each fuse type indicated:

1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
2. Let-through current curves for fuses with current-limiting characteristics.
3. Time-current curves, coordination charts and tables, and related data.

B. Ambient Temperature Adjustment Information. If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses adjusted.

1. For each adjusted fuse, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
2. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

C. Maintenance Data: For tripping devices to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

A. Source Limitations: Provide fuses from a single manufacturer.

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

C. Comply with NEMA FU 1.

D. Comply with NFPA 70.

1.5 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (4.4 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 COORDINATION

A. Coordinate fuse ratings with HVAC and refrigeration equipment nameplate limitations of maximum fuse size.

B. Coordinate fuse ratings for Type 2 protection of motor starters, contacts, and overload relays.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged in original cartons or containers and identified with labels describing contents.

1. Fuses: Quantity equal to twenty percent of each fuse type and size, but not fewer than one set of three of each type and size.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Cooper Industries, Inc.; Bussmann Div.
2. General Electric Co.; Wiring Devices Div.
3. Gould Shawmut.
4. Tracor, Inc.; Littelfuse, Inc. Subsidiary.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Main Service and Feeders, 600A maximum: Class RK1, dual-element, time-delay.

B. Main Service and Feeders, 601 – 6000A: Class L, time-delay.

C. Motor Branch Circuits: Class RK5 or Class J, dual-element, time-delay.

D. Other Branch Circuits: Class RK1, fast-acting.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

A. Install labels indicating fuse replacement information on inside door of each fused switch.

END OF SECTION 264910

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SECTION 265110 - 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, lighting fixtures mounted on exterior building surfaces, lamps, ballasts, emergency lighting units, and accessories.

1.3 SUBMITTALS

A. Product Data: 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 laboratory tests for fixtures and lamps for photometric performance.
3. Emergency lighting unit battery and charger.
4. Fluorescent and high-intensity-discharge ballasts.
5. Types of lamps.

B. Maintenance Data: For lighting fixtures to include in maintenance manuals specified in Division 1.

1.4 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.

B. Comply with NFPA 70.

C. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.

1.5 COORDINATION

A. Fixtures, Mounting Hardware, and Trim: Coordinate layout and installation of lighting fixtures with ceiling system and other construction.

1.6 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, but not less than 5 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for last four years.

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 Electronic Emergency Ballasts: Two years from date of Substantial Completion.

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.

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. Ballasts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
4. Emergency Fluorescent Ballasts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the products indicated for each designation in the Lighting Fixture Schedule.

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. All parts shall be painted after fabrication to facilitate installation, increase efficiency, and inhibit rusting.

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: 90 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: High resistance to yellowing and other changes due to aging, exposure to heat, and ultraviolet radiation.
2. Lens Thickness: 0.125 inch (3 mm) minimum, unless greater thickness is indicated.

2.3 LIGHTING FIXTURES

A. See the "Lighting Fixture Schedule" on plans.
1. Upper case letter at fixture outlet symbol or in note on Drawings indicated the fixture type. Lower case letter at fixture symbol indicated switching circuit. Any outlets not specifically labeled shall be equipment with fixture similar to those in rooms used for like purposes.
2. Fixtures requiring plaster frames or other special frames shall be furnished with these frames as required for type of construction. Fixtures requiring additional accessible outlet connection boxes and additional wiring from outlet box to fixture, shall be furnished with this wiring per the N.E.C. and Local Code requirements. Frames of all recessed fixtures shall be tight to the ceiling to eliminate light leaks. Gasketing shall be used to eliminate all light leaks.

2.4 FLUORESCENT LAMP BALLASTS

A. Electronic type ballast as manufactured by Advance, Energy Savings Inc., Howard Industries, Universal Lighting Technologies, or Sylvania.

B. General Requirements: Unless otherwise indicated, features include the following:

1. Designed for type and quantity of lamps indicated at full light output.
2. Type: Instant start, energy saving.
3. Total Harmonic Distortion Rating: Less than 10 percent.
4. Power Factor: 95 percent, minimum.
5. Ballast Factor: .88, unless noted otherwise.
6. Sound Rating: A.
7. Operating Voltage: Match connected circuits.
8. Multi-lamp Ballasts: Utilize 1, 2, 3, or 4 lamp ballast as required to accommodate switching shown on the drawings.

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. Encapsulation: Without voids in potting compound.
3. Parallel Lamp Circuits: Multiple lamp ballasts connected to maintain full light output on surviving lamps if one or more lamps fail.
4. Minimum Starting Temperature: 0°F.

D. Ballasts for Compact Lamps: Unless otherwise indicated, additional features include the following:

1. Type: Electronic, fully encapsulated in potting compound.
2. Operating Frequency: 20 kHz or higher.
3. Flicker: Less than 5 percent.
4. Lamp Current Crest Factor: Less than 1.7.
5. Transient Protection: Comply with IEEE C62.41 for Category A1 locations.
6. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.

2.5 HIGH-INTENSITY-DISCHARGE LAMP BALLASTS

A. General: Comply with ANSI C82.4. Unless otherwise indicated, features include the following:

1. Type: Regulating high-power-factor type, unless otherwise indicated.
2. Operating Voltage: Match connected circuits.
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.

B. Encapsulation: Manufacturer's standard epoxy-encapsulated model designed to minimize audible fixture noise.

2.6 EXIT SIGNS

A. General Requirements: Comply with UL 924 and the following:

1. Sign Colors and Lettering Size: Comply with authorities having jurisdiction.
2. Wire Guard: Where indicated, heavy-chrome-plated wire guard arranged to protect fixtures.

B. Internally Lighted Signs: As follows:

1. Lamps for AC Operation: Light-emitting diodes, 70,000 hours minimum rated lamp life.

C. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

1. Battery: Sealed, maintenance-free, nickel-cadmium type with special warranty.

2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically energizes lamp from unit when circuit voltage drops to 80 percent of nominal or below. When normal voltage is restored, relay disconnects lamps, and battery is automatically recharged and floated on charger.

2.7 EMERGENCY FLUORESCENT POWER SUPPLY UNIT

A. Electronic type ballast as manufactured by Bodine, Iota, Cooper Lighting, or Prescolite.

B. Internal Type: Self-contained, modular, battery-inverter unit factory mounted within fixture body. Comply with UL 924.

1. Test Switch and Light-Emitting Diode Indicator Light: Visible and accessible built into fixture housing or reflector. Where test switch is not built into the fixture housing or reflector, test switch shall be mounted at a location designated by the engineer, up to 50' away from the fixture location.
2. Minimum Initial Light Output For Linear T8 Lamps: 1100 lumens.
3. Minimum Initial Light Output For Compact Lamps: 700 lumens.
4. Battery: Sealed, maintenance-free, nickel-cadmium type with minimum 7-year nominal life.
5. Charger: Fully automatic, solid-state, constant-current type.
6. Operation: Relay automatically energizes lamp from unit when normal supply circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamp, and battery is automatically recharged and floated on charger.

2.8 LAMPS

A. Lamps as manufactured by Osram Sylvania, Phillips Lighting, or General Electric.

A. High Performance Linear Fluorescent T-8 lamps:
1. Type: Rapid start.
2. Life (48"): 30,000 hrs rated average at 3 hours per start.
3. Life (36" and 24"): 24,000 hrs rated average at 3 hours per start.
4. Color Temperature: 3500K.
5. Color Rendering Index (CRI): 82 minimum.
6. Minimum Initial Lumens: 3100 (48"), 2225 (36"), 1400 (24").
7. Power Rating: 32 watts (48"), 25 watts (36"), 17 watts (24").

B. Compact Fluorescent lamps:
1. Life: 10,000 hrs rated average.
2. Color Temperature: 3500K.
3. Color Rendering Index (CRI): 82 minimum.
4. Amalgam Technology: Lamps shall utilize amalgam technology to maintain stable light output over a wide range of temperatures.

C. Metal-Halide Color Temperature and Minimum Color-Rendering Index:
1. Ceramic Metal Halide T-6, PAR, ED-17 type 150 watts or less: 3000 K and 80 CRI, unless otherwise indicated.
2. Other types: 3200K and 70 CRI, unless otherwise indicated.

2.9 FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Basic Electrical Materials and Methods," for channel- and angle-iron supports and nonmetallic channel and angle supports.

2.10 FINISHES

A. Fixtures: Manufacturer's standard, unless otherwise indicated.

1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects, after fabrication.
2. Metallic Finish: Corrosion resistant.

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.
1. Where specific lamp designations are not indicated or specified, lamp fixtures according to manufacturer’s recommendations.

B. Support for Fixtures in or on Grid-Type Suspended Ceilings: Use grid for support.

1. For fixtures with a weight greater than 7 lbs per square foot of occupied ceiling space, install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches (150 mm) from fixture corners. These rods or wires shall be secured to individual support points directly vertical from attachment point to fixture to the extent possible.
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. Fire Rated Ceilings:

1. Lighting fixtures that are not fire rated for the ceiling they are to be installed in shall be provided with a fire rated enclosure. Enclosure shall be suitable for the application as approved by the local Authority Having Jurisdiction (AHJ). Contractor shall review architectural plans to determine which ceilings, if any, are to be constructed as fire rated assemblies and shall include the protection of any and all light fixtures installed in these ceilings in his/her bid.

D. Exit Light Installation in Grid-Type Suspended or Gyp Board Ceilings:

1. Support electrical boxes firmly to the deck structure utilizing uni-strut or other acceptable means. Fixtures shall not be easily turned or rotated from below.

E. Emergency ballast test switch installation:

1. Where the test switch is not integral to the fixture housing or reflector, install switch at a location designated by the engineer, up to 50’ away from the emergency ballast location.

F. Emergency Lighting Fixtures: Provide unswitched normal building power to all fixtures provided with emergency ballasts or batteries for local power failure indication. The unswitched power connection shall be from a branch circuit serving the lighting in the space in which the emergency lighting is located.

3.2 CONNECTIONS

A. Ground equipment.

1. 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.

3.3 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. 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.

C. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

D. Corrosive Fixtures: Replace during warranty period.

3.4 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.

END OF SECTION 265110

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SECTION 265210 - 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.

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: For each type of lighting unit indicated, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:

1. Materials and dimensions of luminaires and poles.
2. Certified results of laboratory tests for fixtures and lamps for photometric performance.
3. High-intensity-discharge luminaire ballasts.

B. Shop Drawings: Anchor-bolt templates keyed to specific poles and certified by manufacturer.

C. Maintenance Data: For lighting units to include in maintenance manuals specified in Division 1.

1.5 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. Comply with ANSI C2.

C. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING OF POLES

A. 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.

B. Retain factory-applied pole wrappings on metal poles until just before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

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: 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. Warranty period shall be Manufacturer's standard, but not less than three years from date of substantial completion.
2. Color Retention: Warranty against fading, staining, and chalking due to effects of weather and solar radiation. Warranty period shall be Manufacturer's standard, but not less than three years from date of substantial completion.
3. Lamp Warranty Period: Replace lamps that fail within 12 months 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. Ballasts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the products indicated for each designation in the Lighting Fixture Schedule.

2.2 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.

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. High-Intensity-Discharge Ballasts: Comply with ANSI C82.4. Constant wattage autotransformer or regulating high-power-factor type, unless otherwise indicated.

1. Ballast Fuses: One in each ungrounded supply conductor. Voltage and current ratings as recommended by ballast manufacturer.
2. Single-Lamp Ballasts: Minimum starting temperature of minus 25 deg C.
3. Open-circuit operation will not reduce average life.
4. Noise: Uniformly quiet operation, with a noise rating of B or better.

K. 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.
1. Lamps as manufactured by Osram Sylvania, Phillips Lighting, or General Electric.
2. Metal-Halide Color Temperature and Minimum Color-Rendering Index: 3200 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 90 mph. Support assembly includes pole or other support structures, brackets, arms, appurtenances, base, and anchorage and foundation.

1. Strength Analysis: For each pole type and luminaire combination, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.3 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: Anchor type with hold-down or anchor bolts, leveling nuts, and bolt covers.

F. Steel Poles: Tubing complying with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig (317 MPa); one-piece construction up to 40 feet (12 m) in length with access handhole in pole wall.

1. Grounding Provisions for Metal Pole/Support Structure: Welded 1/2-inch (12-mm) threaded lug, accessible through handhole and listed for copper conductor connection.
   a. Handhole cover shall be suitable for use in wet locations.

2. Shafts: Square, straight.

G. Metal Pole Brackets: Match pole metal. Provide cantilever brackets without underbrace, in sizes and styles indicated, with straight tubular end section to accommodate luminaire.

H. Concrete for Pole Foundations: Comply with Division 3 Section "Cast-in-Place Concrete."

1. Design Strength: 3000-psig (20.7-MPa), 28-day compressive strength.

2.4 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Steel: Grind welds and polish surfaces to a smooth, even finish.

1. Galvanized Finish: Hot-dip galvanize after fabrication to comply with ASTM A 123.
2. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."

3. Interior: Apply one coat of bituminous paint on interior of pole, or otherwise treat to prevent corrosion.
4. Polyurethane Enamel: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

    a. Color: As indicated by manufacturer's designations.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Concrete Foundations: Construct according to Division 3 Section "Cast-in-Place 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 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.

C. Luminaire Attachment: Fasten to indicated structural supports.

D. Lamp luminaires with indicated lamps according to manufacturer's written instructions. Replace malfunctioning lamps.

3.2 CONNECTIONS

A. Ground equipment.

1. 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.

B. Ground metal poles/support structures according to Division 26 Section "Grounding."

3.3 FIELD QUALITY CONTROL

A. Inspect each installed unit for damage. Replace damaged units.

B. Tests and Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source, and as follows:
1. Check intensity and uniformity of illumination.
2. Check excessively noisy ballasts.

C. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

3.4 CLEANING AND ADJUSTING

A. Clean units after installation. Use methods and materials recommended by manufacturer.

B. Adjust aimable luminaires as directed and coordinated with the owner and engineer to provide required light distributions and intensities.

END OF SECTION 265210

SECTION 277260 - PUBLIC ADDRESS AND MUSIC EQUIPMENT

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 all labor, materials, equipment, and related services for amplifying, distributing, and reproducing sound signals.

B. The Paging Sound System shall consist of amplifier, speakers, and other devices, as required to form a complete system. The mixer/amplifier and associated equipment shall be housed in an equipment rack located at the existing penthouse of each school.

C. Paging access shall be on an all call basis, utilizing the customer provided telephone system for page initiation.

1.3 PERFORMANCE REQUIREMENTS

A. System Functions: Include the following:

1. Paging, by dialing an extension from any local telephone instrument and speaking into the telephone.
2. Reproducing high-quality sound that is free from noise and distortion at all loudspeakers at all times during equipment operation, including standby mode with inputs off; and output free from non-uniform coverage of amplified sound.
3. Ability to distribute background music.
4. Ability to accept program music inputs.

1.4 SUBMITTALS, SHOP DRAWINGS & MAINTENANCE MANUALS

A. Submittals shall be provided in accordance with Division 1 and as further described herein.

B. Submittals shall include major equipment material lists, summarizing every item to be provided, by manufacturer, part number, quantity, and include a brief summary of each item. Manufacturer’s product data sheets, describing each of the major components shall also be provided.

C. Submittals shall be tab divided to aid in identifying the various sections of the submittal.

D. Shop drawings shall include complete floor plan drawings showing device locations, conduit routing, wire and cable quantity and sizes. Functional block diagrams, complete termination diagrams, showing all headend, control and typical field devices, shall also accompany the submittal. Provide proposed equipment rack layout.

E. Point to Point termination charts shall be included, identifying all punch block, panel and intermediate termination points, as well as defining wire and cable color codes and identification schemes to be followed throughout construction.

F. Maintenance manuals shall be compiled in accordance with the Division 1, shall include all information provided as part of the original submittal and shall also be updated to include installation notes, manufacturer's manuals, etc. Manuals shall also include:
   1. Descriptions of all equipment and detailed operating instructions.
   2. Final shop drawings, updated to reflect "as-built" accuracy. Include outlets with label ID's, and cable designations and routing information.
   3. Field test reports shall be provided, indicating and interpreting test results for compliance with performance requirements of the Project.
   4. Maintenance data shall be included for all major pieces of equipment, as per the requirements specified in Division 1.
   5. Copy of major equipment manufacturer's standard warranty statements, for future reference and use, should claims need to be submitted.

1.5 QUALITY ASSURANCE

A. Product Quality
   1. Equipment described in this Section shall be provided by a company regularly engaged in the design, sale and installation of Public Address Sound Systems. This company shall also have a service organization, trained by the equipment manufacturer and located a reasonable distance from the jobsite, which is capable of maintaining the system once installed. The services of this company shall be retained by the Electrical Contractor to supervise the system design, installation, make final system connections, and perform all tests and balance work required.
   2. All basic electronic equipment shall be listed by Underwriter's Laboratories, Inc. for the application and shall be products of manufacturers of established reputation and experience.

B. Contractor Qualifications
   1. The Installing Contractor shall be a firm specializing in the type of work called out in this specification section and shall, upon request, provide documentation that they have successfully completed at least three other installations of similar size and scope to this installation.
   2. The Installing Contractor (and any Subcontractors working for the Installing Contractor) shall be licensed, in accordance with local, regional and state authorities having jurisdiction, to complete the work that they are contracted to perform.

1.6 COORDINATION

A. Coordinate work of this section with the owners digital telephone switching system supplier for interface requirements. It is the intent of this specification to ensure that this public address sound system be interfaced to and work in an integrated manner with the digital telephone switching system.

   1. To that end, this contractor shall include all costs of labor and materials necessary to ensure that the public address system interface is complete and functioning with the digital telephone switching system.

2. This contractor shall work with the digital telephone switching system provider, at no additional cost to the owner, to complete all tie-ins between the public address system and the telephone switch and to ensure that the entire integrated system operates properly and is properly documented for the owner's use.

1.7 OCCUPANCY ADJUSTMENTS

A. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions. Provide up to two on-site assistance visits within one year of Substantial Completion.

PART 2 - PRODUCTS

2.1 APPROVALS

A. The Products that are to be provided to form the system described herein are defined both functionally and descriptively. It is to be understood that these explanations are provided to establish minimum acceptable standards of performance and appearance. Product make and model numbers have also been provided to further define and more closely describe specific operational characteristics and/ or to make the contractor aware of the owner’s preference for particular products.

B. If, in the estimation of a qualified potential supplier or installer, equipment of other manufacture could be substituted without compromising the integrity of the installation or its’ overall design intent, then a request for consideration to substitute said product must be made in writing at least seven (7) days prior to bid date, fully describing the substitution.

C. Any exceptions to specifications, in terms of product appearance, configuration, operation or capabilities, which alter a potential bidders ability to meet these specifications shall be fully disclosed to the Architect/ Engineer at the time a request for approval to bid is received.
   1. Operational features and characteristics which exceed the requirements set forth in this specification as a minimum standard need not be disclosed at the time of product consideration for approval.

D. Notice of all bidder and product approvals shall be by addendum issued prior to bid date.

2.2 EQUIPMENT

A. Coordinate features to form an integrated system. Match components and interconnections for optimum performance of specified functions.

B. Equipment: Modular type, using solid-state components, fully rated for continuous duty, unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.

C. Waterproof Equipment: Listed and labeled for duty outdoors or in damp locations.

2.3 EQUIPMENT ENCLOSURE

A. The sound system equipment enclosure shall be a Soundolier Model 307-12 surface wall enclosure with hinged door and mid section. Enclosure to be painted black. Ensure that adequate side clearance (minimum of 15") is maintained to allow opening of enclosure for servicing. Provide blank and vented panels as required for all unused rack spaces.

B. Provide a rack mount shelf to mount Owner provided music sources, as well as miscellaneous sound equipment, patch cords, and accessories. Shelf shall be Middle Atlantic RSH Series, 14" deep.

2.4 COMPONENTS

A. A package type Mixer Amplifier shall be provided to accept both paging and music inputs. This amplifier shall serve all building speakers. Amplifier shall be rated at 240 watts continuous and include individual input controls (minimum of 5), master volume and tone controls. Inputs shall accommodate microphone, telephone, and auxiliary music sources , as required for the application. Amplifier response shall be ±3dB from 50Hz to 20,000Hz with distortion at less than 1% at RPO. Amplifier shall be an Atlas Sound Model AA240 with AARMK2-0 rack mount kit.
   1. Provide an AAIT-600 transformer for interface with the owner provided telephone system.

B. Provide a rack mount power distribution unit, rated at 15 amps, equipped with 8 rear outlets and one front outlet and mount it within the free-standing data rack. Unit shall include surge and spike protection, EMI filtering, and a 9' cord. An illuminated combination power switch/circuit breaker shall be located on the front panel of the unit. Power distribution unit shall be Middle Atlantic PD-915R.

C. Miscellaneous Controls and Power Supplies: Provide all special controls, auxiliary power supplies, relays, matching transformers, etc., required and necessary to accomplish the system operation described in these specifications.

D. Recessed Ceiling Speaker Assembly shall consist of Soundolier 62-8(w) round aluminum baffle with blind mounting studs and finished in baked white enamel. The back-box shall be a Soundolier EZ96-8 type with tile bridge hanger support channels. Speakers shall be Soundolier C5AT70, 8" cone speaker with whizzer cone and 70V matching transformer. Contractor shall verify ceiling type with architectural reflected ceiling plans.

E. Surface Ceiling Speaker Assembly shall consist of Soundolier 161-8 (w) square baffle with blind mounting studs and finished in baked white enamel. The back-box shall be a Soundolier SE175-4 type with white finish. Speakers shall be Soundolier C5AT70, 8" cone speaker with whizzer cone and 70V matching transformer. Contractor shall verify ceiling type with architectural reflected ceiling plans.

F. Interior Paging Trumpet Speakers (Located in Commons and Gym): Speakers shall be TOA SC-615T. Units shall be single-horn type, with minimum full-range power rating of 15 W. Provide with 70V matching transformer with three standard taps. Provide with integral mounting bracket.
   1. Provide wire guards where shown on the plans.

G. Exterior flush mounted speaker assemblies shall be Atlas Sound APF-15T loudspeaker with matching transformer. Provide VP161-APF recess mount square baffle and 193-8-6 backbox. Baffle finish to be flat black.

H. Wire and Cable shall be as recommended by the equipment manufacturer. In general, conductors shall be stranded and not less than #18 ga. for all speaker runs. Cables shall bear either a CL2 or CL2P label, as required for the application.

1. Cables shall bear the CL2P label and be listed for Plenum use where required.
2. Speaker Cable shall be equal to West Penn 293 or 25293, #18 ga., twisted, shielded pair type.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The installation shall be in accordance with the latest requirements of the NEC, State, and Local Codes, ordinances and regulations of any other governing body having jurisdiction

B. All equipment shall be installed in a neat and workmanlike manner and to the satisfaction of the Project Engineer.

C. Install equipment to comply with manufacturer's written instructions.

D. Wiring Method: Install wiring in raceway and cable tray (where provided) except within consoles, cabinets, desks, counters, accessible ceiling spaces, and in gypsum board partitions where “free air” cable wiring method may be used. Use UL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and wiring except in unfinished spaces. All cabling routed at exposed ceiling structure in finished spaces shall be installed in raceway. All cabling installed underground or underslab shall be wet location listed.

1. Whether system cabling is installed in cable tray or “free air”, the system cabling shall be neatly run and shall be bundled separately from all other systems cabling.

2. Where cable is run “free air”, the cable shall be rated for the intended use and shall be neatly run and supported, using acceptable means to ensure reliable installation and performance.
   a. Install cable parallel and perpendicular to surfaces or exposed structural members, and follow surface contours where possible.
   b. Install sleeves for cable penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls. Provide insulated bushings for protection of conductors.
   c. Secure and support cable at intervals not exceeding 8 feet and not more than 12 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   d. Utilize cable distribution rings and hangers, standoffs, spools and other suitable devices as an aid in managing all cable runs. Where cable tray is not provided and where 10 or more cables are routed together, cable distribution rings or hangers shall be wall or ceiling mounted above accessible ceilings at varying 4 to 6 foot intervals.

e. Cables shall not be laid on or draped across any ceiling tiles, grids, electrical or mechanical fixtures. Maintain at least a 12 inch separation between the communications cables and fluorescent or HID lighting.
f. Cables shall not be strapped, taped, or attached by any means to the exterior of any conduit or raceway as a means of support.

E. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess. Use lacing bars in cabinets.

F. Control-Circuit Wiring: Install number and size of conductors as recommended by system manufacturer for control functions indicated.

G. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches (300 mm) for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

H. Splices, Taps, and Terminations: Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

I. All shields for speaker and microphone/auxiliary cables shall be maintained whole, unbroken, and isolated from ground at all locations except the control headend.

J. Match input and output impedance and signal levels at signal interfaces. Provide matching networks where required.

K. Identification:
1. Color-code conductors and apply wire and cable marking tape to designate wires and cables to identify media in coordination with system wiring diagrams.
2. Mark all control settings with small adhesive “dots”.

L. Conductor Sizing: Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 18 AWG and conductors from microphone receptacles to amplifiers not smaller than No. 22 AWG.

M. Weatherproof Equipment: Install units that are mounted outdoors, in damp locations, or where exposed to weather consistent with requirements of weatherproof rating.

N. Line Matching Transformer Connections: Make initial connections using tap settings indicated on Drawings.

3.2 GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installations, including connections. Report results in writing.

B. All devices, including speakers, shall have final connections made be persons familiar with the trade. Work to be accomplished in craftsman-like manner. Installer shall test, calibrate, and adjust all speaker tap settings and controls to obtain the best, most uniform coverage possible for the application.

C. Operational Test: Perform tests that include originating program and page material at telephone instruments, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and freedom from noise and distortion.

1. Measure and record the impedance of each loudspeaker line before connecting it to the output of its respective amplifier.
2. Measure and record the output impedance of each active device operating as a source to any passive device or series of passive devices.
3. Measure and record the input impedance of any active device used to terminate passive devices.

D. Power Output Test: Measure electrical power output of each power amplifier at normal gain setting at 50, 1000, and 12,000 Hz. Maximum variation in power output at these frequencies must not exceed plus or minus 1 dB.

E. Signal Ground Test: Measure and report ground resistance at pubic address equipment signal ground. Comply with testing requirements specified in Division 26 Section "Grounding."

F. Retesting: Correct deficiencies, revising tap settings of speaker-line matching transformers where necessary to optimize volume and uniformity of sound levels, and retest. Prepare written record tests.

G. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.

H. Schedule tests with at least seven days' advance notice of test performance.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain equipment as specified below:

1. Train Owners maintenance personnel on programming equipment for starting up and shutting down, troubleshooting, servicing, and maintaining equipment. Provide a maximum of one training session, to last no more than one (2) hour each, prior to occupancy.
2. Review data in maintenance manuals.
3. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION 277260

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SECTION 277290 - RF BROADBAND TV & LOCAL A/V DISTRIBUTION 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.

1.2 SUMMARY

A. This Section includes all labor, materials, equipment and related services to furnish and install the TV Distribution System, including Local A/V Distribution System, as shown on the drawings and specified herein.

B. The work to be provided under these specifications consists of furnishing and installing a complete RF Distribution System up to and including headend distribution amplifier and interface to the Owner provided Cable TV Signal source. This Contractor shall furnish all necessary equipment, labor, and installation materials necessary to provide a complete distribution system.

C. This Specification Section has also been expanded to include the infrastructure cabling necessary to support local audio-video (A/V) distribution between A/V source and destination equipment within the confines of specific rooms, as noted on the plans.

D. Audio-Video (A/V) Hardware Exclusions
   1. This specification section limits audio-video (A/V) distribution to the actual hardwired infrastructure (wiring, cabling, outlets and terminations) and does NOT address nor make provisions for furnishing, installing, setting up or testing any type of external or equipment specific hardware, patch cables or jumper cables that may be necessary to actually final terminate and interconnect various types of A/V hardware pieces together.
   2. It is to understood that all active audio-video equipment; including but not limited to players and receivers (such as- VCR’s, DVD players, CD players, laptop computers, central process controllers, projectors, TV sets, twisted pair transceivers, etc.) is to be “Owner Provided” OUTSIDE the scope of this project and this specification.
   3. Likewise, audio-video (A/V) patch cables and jumpers are also excluded from the scope of this project and this specification.

1.3 SUBMITTALS, SHOP DRAWINGS & MAINTENANCE MANUALS

A. Submittals shall be provided in accordance with Division 1 and as further described herein.

B. Submittals shall include major equipment material lists, summarizing every item to be provided, by manufacturer, part number, quantity, and include a brief summary of each item. Manufacturer’s product data sheets, describing each of the major components shall also be provided.

C. Submittals shall be tab divided to aid in identifying the various sections of the submittal.

D. Shop drawings shall include complete floor plan drawings showing device locations, conduit routing, wire and cable quantity and sizes. Functional block diagrams, complete termination diagrams, showing all headend, control and typical field devices, shall also accompany the submittal.

E. Maintenance manuals shall be compiled in accordance with the Division 1, shall include all information provided as part of the original submittal and shall also be updated to include installation notes, manufacturer's manuals, etc. Manuals shall also include:
   1. Descriptions of all equipment and normal operations
   2. Final shop drawings, updated to reflect "as-built" accuracy. Include outlets with label ID's, and cable designations and routing information.
   3. Field test reports shall be provided, indicating and interpreting test results for compliance with performance requirements of the Project.
   4. Maintenance data shall be included for all major pieces of equipment, as per the requirements specified in Division 1.
   5. Copy of major equipment manufacturer's standard warranty statements, for future reference and use, should claims need to be submitted.

1.4 QUALITY ASSURANCE

A. Product Quality
   1. Equipment described in this Section shall be provided by a company regularly engaged in the design, sale and installation of RF Broadband TV Distribution Systems. This company shall also have a service organization, trained by the equipment manufacturer and located a reasonable distance from the jobsite, which is capable of maintaining the system once installed. The services of this company shall be retained by the Electrical Contractor to supervise the system design, installation, make final system connections, and perform all tests and balance work required.
   2. All basic electronic equipment shall be listed by Underwriter's Laboratories, Inc. for the application and shall be products of manufacturers of established reputation and experience.

B. Contractor Qualifications
   1. The Installing Contractor shall be a firm specializing in the type of work called out in this specification section and shall, upon request, provide documentation that they have successfully completed at least three other installations of similar size and scope to this installation.
   2. The Installing Contractor (and any Subcontractors working for the Installing Contractor) shall be licensed, in accordance with local, regional and state authorities having jurisdiction, to complete the work that they are contracted to perform.

1.5 CONFIGURATION

A. The TV Distribution System shall provide for reception of both color and monochrome television signals at any outlet in the system equal to that obtainable by a single standard receiver connected directly to the CATV feed.

B. The TV Distribution System shall meet or exceed the technical standards set forth in FCC Rules, Part 76.

C. TV Distribution Equipment shall also be capable of providing two-way (bi-directional) communication over a single cable. Implementation of two-way communications shall not make present equipment obsolete, but shall require only the addition of future headend equipment.

D. Bandwidth of all passive devices shall be from 50 MHz to 1000 MHz in the forward direction, and from 5 MHz to 50 MHz in the reverse path.

E. The TV Distribution System shall be designed for minus 46 dB cross-modulation or better, and a carrier-to-noise ratio of at least 43 dB.

F. Isolation between any two outlets in the TV system shall be a minimum of 20 dB on any TV frequency.

G. All outlets in the TV system shall provide a minimum level of +0 dBmv and a maximum of +12 dBmv across the entire passband range, with a design level of +6dBmv, nominal. Provide additional amplifiers, as specified and required, to accomplish this requirement.

H. Under the scope of this project, a complete TV Distribution system, including headend broadband amplifiers are to be provided. All necessary headend amplification equipment, modulators, converters, etc., shall also be provided by this Contractor.

I. Under the scope of this contract, no TV sets are to be provided and no wall brackets for mounting of TV sets are to be installed. The Owner will contract for this work separately outside the scope of this contract.

J. Coordination of TV Cable feed is to by the Owner, outside the scope of this project.

K. The TV Distribution System described herein and shown on plans shall be installed in a "standard room drop" configuration, utilizing a broadband trunk circulating throughout the commons areas and hallways and connected to directional tap devices, room drop cables and feed thru outlets.

1.6 IN-HOUSE ORIGINATION PROGRAMMING CAPABILITIES

A. Under the scope of this contract, there are to be no provisions for In-House Origination Programming.

1.7 MEDIA RETRIEVAL & MEDIA SCHEDULING

A. Under the scope of this contract, there are to be no provisions for Media Retrieval or automatic time of day scheduling or remote control of any of the A/V Sources.

1.8 BULLETIN BOARD MESSAGING

A. Under the scope of this contract, there is to be no bulletin board messaging capabilities (no character or graphics generator or associated processors or modulators).

PART 2 - PRODUCTS

2.1 APPROVALS

A. The Products that are to be provided to form the system described herein are defined both functionally and descriptively. It is to be understood that these explanations are provided to establish minimum acceptable standards of performance and appearance. Product make and model numbers have also been provided to further define and more closely describe specific operational characteristics and/ or to make the contractor aware of the owner's preference for particular products.

B. If, in the estimation of a qualified potential supplier or installer, equipment of other manufacture could be substituted without compromising the integrity of the installation or its' overall design intent, then a request for consideration to substitute said product must be made in writing at least seven (7) days prior to bid date, fully describing the substitution.

C. Any exceptions to specifications, in terms of product appearance, configuration, operation or capabilities, which alter a potential bidders ability to meet these specifications, shall be fully disclosed to the Architect/ Engineer at the time a request for approval to bid is received.
   1. Operational features and characteristics which exceed the requirements set forth in this specification as a minimum standard need not be disclosed at the time of product consideration for approval.

D. Notice of all bidder and product approvals shall be by addendum issued prior to bid date.

2.2 VHF/UHF BROADBAND AMPLIFIERS

A. Broadband amplifiers shall be provided to amplify all incoming CATV. No "cherry picking" or "channel blocking" is required beyond that already found on the existing combined feed.

B. Amplifiers shall be sized for the present project, with headroom to accommodate moderate future growth of the distribution system.

C. Amplifiers shall operate with a minimum full gain of +43 dBmv across the entire CATV spectrum (50-860 MHz), with an output capability of at least 42 dB into a system configured with one hundred twenty-nine (129) active channels. Amplifiers shall be of push-pull design, offer power doubling where appropriate, and operate within the following parameters- cross modulation at –54dB or better, composite triple beat at –50dB or better.

D. Gain, output level and tilt adjust controls shall all be provided on the face of the amplifier.

E. A tunable FM trap with 10 dB notch filter shall also be provided, where deemed necessary. The units shall be powered at 115 VAC.

F. Broadband Amplifiers shall be equal to a Blonder-Tongue Model BIDA 86A-43.

2.3 DIRECTIONAL COUPLER TAPS

A. Directional coupler type taps shall be provided as required for signal distribution. The taps shall be fully shielded and in compliance with FCC rules pertaining to radiation and have 120 dB minimum RF shielding. The taps shall be available in standard isolation values from 4 to 30 dB. Frequency response through any port shall be from 5 MHz to 1000 MHz.

B. Directional coupler taps shall provide through loss of less than 1.2 dB and back match in excess of 18 dB. Any combination of taps shall provide a minimum isolation between tap ports of 18 dB. All cable connections shall be by "F" type fittings. Taps shall be solder-back type housed in a rugged cast aluminum case.

C. Single port taps shall be Blonder-Tongue SRT series and four port taps shall be Blonder-Tongue SDC4 series.

2.4 TV ROOM OUTLETS

A. Standard TV Room Outlet Plates
   1. Where noted on plans with the symbol “TV”, standard TV Room outlets shall be provided. Plate appearance shall be that of a decora (GFCI) style receptacle, with gray subplate. An “F” type feed through jacks shall pass through the face of the subplate. Provide a stainless steel 302 cover plate that matches other electrical outlets in the room.
   2. TV Room Outlets shall be equal to Leviton 40681-GY or Quiktron 2601-03957-000.
   3. Provide directional coupler (DC) type tap-offs in outlet backbox, where required to support daisy chain applications.

2.5 AUDIO-VIDEO (A/V) ROOM OUTLETS

A. Where noted on plans with the symbol “AV”, combination Audio-Video (A/V) Outlets shall be provided and installed.
   1. Outlets shall be custom fabricated and include an “F” feed through jack, as well as various types of audio and video termination jacks, as further described herein. Refer to fabrication details found on electrical plansheets for general layout information.
   2. Cover Trim Plates shall be made of stamped 302 stainless steel material and sized appropriately for the application.
   3. Audio, video, TV, and data jacks may be either direct “through-plate” mounted or loaded into plastic subplates designed specifically to accommodate the jacks.
      a. Where subplates are used they shall be that of a decora (GFCI) style receptacle and both the subplate and any A/V insert jacks shall be finished in color gray.
      b. Where A/V jacks are mounted directly through a stainless steel plate, jacks shall be fitted with insulating bushings (or plastic inserts), ensuring that the jacks remain electrically isolated from the plates and associated electrical boxes and raceway system.

B. Each Audio Video Outlet shall be configured as follows:
   (1) 2-gang decora style stainless steel plate
   (1) Quicktron 2212-42334-001 white decora insert consisting of (1) HD15, (1) 3.5mm stereo audio, and (3) RCA (composite video, left audio, and right audio) jacks and lead-off connector.

(1) F81 Threaded Feed through “F” Barrel connector (isolated)
(2) Dedicated Data Jacks.

C. At all AV outlet locations, dedicated dual data jacks shall also be provided.
1. Purpose for these dedicated data jacks is to provide separate, dedicated (hard copper) pathways between the lower and upper outlet locations, in support of “future” digital audio and video signal transport, such as those meeting DVI and HDMI standards.
2. These dual jacks are to connect to each other (pin for pin) and will be used in conjunction with various types of “twisted pair” A/V products to translate, transmit and receive various types of A/V information in the future.
3. Data jacks are to consist of standard, modular, Category 5e, UTP, data grade type jacks, similar in type and construction to Leviton QuickPort Model 5G108-RY5 jacks and finished in the color YELLOW to set the jacks apart from other LAN connected Data jacks, that might be found in proximity to these dedicated use video jacks.
4. Data jacks are to be terminated in accordance with EIA T568A standard.

D. Associated Audio-Video (A/V) Hardware & Distribution Equipment
1. Under the scope of this contract NO A/V hardware (twisted pair products, amplifiers, scalers, bridgers, transmitters, receivers, etc.) are to be provided OR installed. These products are to be “Owner Provided”.
2. Under the scope of this contract NO patch cables or jumpers are to be provided OR installed. These products are to be “Owner Provided”.

2.6 MIXING AND SPLITTING DEVICES

A. Broadband mixing/splitting devices shall be used in the system as required. These units shall be solder-back type, housed in rugged, cast aluminum housings, equipped with flanges to permit mounting on any flat surface. Units shall meet FCC specifications on radiation and have 120 dB minimum RF shielding.

B. All units shall have a frequency response from 5 MHz to 1000 MHz. Two-way splitters shall have a maximum splitting loss of 4.5 dB. Four-way splitters shall have a maximum splitting loss of 7.7 dB.

C. Two Way Splitters shall be Blonder-Tongue SRT type and Four Way Splitters shall be Blonder-Tongue SRT4 type.

2.7 WIRE & CABLE

A. Two types of coaxial cables shall be used for the distribution system, in RG-6 and RG-11 sizes. The larger cable is to be used for all trunk lines, with the smaller dimension cable being reserved for shorter feed lines and room drops. Coaxial cable shall be of 75 ohm impedance with a return loss of 20 dB minimum from 5 MHz to 1000 MHz. Cable construction shall be solid bare copper conductor and cellular polyethylene dielectric. Cable jackets shall be black, non-contaminating, low temperature, polyvinyl chloride or chlorinated polyethylene.

1. RG-6 size cable shall have a nominal loss per 100 feet of 0.50 dB at 5 MHz, 1.5 dB at 50 MHz, and 5.0 dB at 450 MHz. The center conductor shall be #18 AWG copper clad steel with a dielectric O.D. of 0.17 inches. Overall cable O.D. shall be no greater than 0.254 inches. Shield shall be bifoil type with 100% aluminum clad mylar and a separate 80% aluminum braid.

2. RG11/U size cable shall be QUAD shielded type, and shall have a nominal loss per 100 feet of 0.30 dB at 5 MHz, 1.0 dB at 50 MHz, and 3.5 dB at 450 MHz. The center conductor shall be #14 AWG copper clad steel, or CCS, with a dielectric O.D. of 0.280 inches. Overall cable O.D. shall not be greater than 0.450 inches. The RG11/U cable shall include quad shielding with (2) bifoil shields and (2) aluminum braided shields.

B. Individual drain wires in lieu of braid are not acceptable.

C. Coaxial cables shall be equal to Coleman 921015, in RG6 size.

D. Coaxial cables shall be equal to West Penn 25Q821, in RG11 size.

E. Pre-connectorized cable shall be provided to connect the HD15, 3.5mm audio and (3) RCA jacks within the integrated faceplate at the hi and low A/V outlet locations. Cable shall be Rapid Run 2212-50730-035, plenum rated, 35' length, and shall be connected to the lead on the faceplate at each end. Longer lengths of cables shall be provided as required for distances between the A/V outlets.

F. Data Grade Cables, equal to Hitachi Model 39419-8, shall be provided to interconnect the Dual Jack Outlets together.
1. Provide one cable for each high-low jack pairing. (In other words, two cables are required to connect the two dual jacks at each location to each other.)
2. Cable shall 4 pair, CAT5e PL rated.

G. All open air cabling shall be plenum type.

H. Patch (Jumper) Cables and Accessories
1. For this project, there are to be NO patch cables or jumpers provided. Such cabling is to be "Owner furnished" outside the scope of this construction contract.

2.8 CABLE CONNECTORS

A. Coaxial cable connectors shall be used to connect to equipment as required. Connectors shall be solder-less, 75-ohm impedance and be designed for the specific type of cable used. "Screw-on" type connectors are NOT acceptable. Splices in any coaxial cable line are not acceptable, unless splice connectors specifically designed for the purpose are available and used.

B. "F" Type Mating Connectors, required at each outlet and tap, shall be of a type designed specifically to minimize RF leakage. "F" Connectors shall have attached rings with sleeve length of at least 5/8" and be designed for 360^{O} crimping, using a compression type (radial) crimp tool to form a concentric seal. Crimp connectors that have a separate crimp ring and/or are to be crimped using a hex crimp tool are NOT acceptable. Connectors used outdoors shall also have an "O" ring, or other type of seal, to maintain electrical integrity in such an environment.

C. In RG11 size, cable connectors shall be of single or two-piece, with built-in stinger and threaded hex "F" barrel. Sleave shall form a 360^{O} concentric seal when crimped using a compression tool. Provide connectors equal to ICM/F-CONN FS11V (plenum) and F11NR (non-plenum).

D. In RG6 size, cable connectors shall be equal to ICM/F-CONN RG6WR, RG6NR or DB6 series. LRC SNS (snap-n-seal) and Gilbert GF-UE (ultra-ease) series connectors shall be considered equal. Use plenum or non-plenum versions of these connectors, as appropriate.

2.9 EQUIPMENT HOUSINGS, RACKS & TERMINATION BOARDS

A. Broadband amplifiers, signal processors and miscellaneous splitters shall be mounted on a data termination board, where noted on plans. Terminal board shall be of ¾" plywood, sized for the application and painted with two coats of gray fire retardant paint. Reserve at least 24"x48" of space at each termination board location for cable TV makeup. Electrical Contractor shall also provide a surface mounted duplex power receptacle at each panel board, to accommodate any present or future amplification equipment that may be needed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The installation shall be in accordance with the latest requirements of the NEC, State, and Local Codes, ordinances and regulations of any other governing body having jurisdiction

B. All equipment shall be installed in a neat and workmanlike manner and to the satisfaction of the Project Engineer.

C. Cable shall be adequately supported, and connectors specifically designed for the type cable in use shall be installed.

D. All equipment shall be suitably mounted in cabinets, junction boxes, or otherwise solidly supported. Equipment suspended by its coaxial connection is not acceptable.

E. Electronic equipment, antennas, antenna supports, etc., shall be bonded to earth ground using #6 solid copper wire extended to the building electrical ground point.

F. Amplifier input cables shall not be bundled with output cables.

G. All outdoor connections shall be weatherproofed through use of weather boots or other approved methods.

H. Wiring Method: Install wiring in raceway and cable tray (where provided) except within consoles, cabinets, desks, counters, accessible ceiling spaces, and in gypsum board partitions where "free air" cable wiring method may be used. Use UL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and wiring except in unfinished spaces. All cabling routed at exposed ceiling structure in finished spaces shall be installed in raceway. All wiring installed underground or underslab shall be wet location listed.

1. Whether system cabling is installed in cable tray or "free air", the system cabling shall be neatly run and shall be bundled separately from all other systems cabling.

2. Where cable is run "free air", the cable shall be rated for the intended use and shall be neatly run and supported, using acceptable means to ensure reliable installation and performance.

a. Install cable parallel and perpendicular to surfaces or exposed structural members, and follow surface contours where possible.
b. Install sleeves for cable penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls. Provide insulated bushings for protection of conductors.
c. Secure and support cable at intervals not exceeding 8 feet and not more than 12 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
d. Utilize cable distribution rings and hangers, standoffs, spools and other suitable devices as an aid in managing all cable runs. Where cable tray is not provided and where 10 or more cables are routed together, cable distribution rings or hangers shall be wall or ceiling mounted above accessible ceilings at varying 4 to 6 foot intervals.
e. Cables shall not be laid on or draped across any ceiling tiles, grids, electrical or mechanical fixtures. Maintain at least a 12 inch separation between the communications cables and fluorescent or HID lighting.
f. Cables shall not be strapped, taped, or attached by any means to the exterior of any conduit or raceway as a means of support.

3.2 SYSTEM TESTS

A. Upon completion of the system installation, it shall be the responsibility of this Contractor to perform all necessary adjustments and balancing of all signal levels to ensure proper system operation.

B. The system shall be physically inspected by an authorized Representative of the equipment manufacturer, ensuring that all equipment is installed in a neat and workmanlike manner as called for by the plans and specifications.

C. Before the contract shall be considered complete, the Contractor shall conduct an operating test for approval. The system shall be demonstrated to operate in accordance with the requirements of these specifications. The test shall be performed in the presence of the Engineer. The Contractor shall furnish all equipment and personnel required for the tests.

D. RF Distribution System Testing
1. Each cable feeder line shall be inspected for proper termination.
2. Using a field strength meter, measure the signal level at the last outlet on each feeder line and other randomly selected outlets totaling not less than 25 percent of the total number of outlets. At any outlet, signal levels shall be more than 0dBmv and less that 12dBmv, as measured on any active channel.
3. Using a standard TV receiver connected to randomly selected outlets, not less than one per feeder, observe picture quality. No visible components of cross-modulation (windshield wiper effect) ghosting or beat interference shall appear on the screen of a receiver tuned to any normal channel.
4. Provide complete documentation of tests performed, including action taken to resolve any problems discovered.

E. Audio-Video (A/V) Outlet Testing
1. Using a high impedance continuity tester, each wire connection at each A/V outlet shall be tested for “end-to-end” integrity and isolation from ground and other wires.

2. Verify that there are no crossed, shorted, open or otherwise compromised connections and, if found, correct such problems.
3. Provide complete documentation of tests performed, including action taken to resolve any problems discovered.

3.3 DOCUMENTATION

A. Upon completion of work, three (3) complete sets of Operator/Maintenance (O&M) Manuals shall be compiled and released to the Owner.

B. Manuals shall include, but not be limited to, complete sets of “as built” floor plans and termination drawings, material lists, product data sheets, as well as the manufacturer’s published (O&M) literature.

C. Manuals shall be prepared, divided, and identified by system type to ensure ease of use in the future.

3.4 WARRANTY

A. The entire installation shall be guaranteed against all defects in materials and workmanship for a period of one (1) year from date of system acceptance. First response to a problem during the first year shall be provided by factory-trained personnel representing the various equipment suppliers. This response is to include maintenance, repair, or replacement of any equipment found to be defective, provided the defect is not caused by misuse, abuse, neglect, or unauthorized tampering or modification. All labor, shipping, transportation and related expenses are to be at no additional cost to the Owner for any warranty service provided.

END OF SECTION 277290

SECTION 277300 – GYM SOUND REINFORCEMENT SYSTEM

PART 1 - GENERAL

1.1 SCOPE

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

B. This Contractor shall furnish, install, and place into operation a complete Sound Reinforcement System for use in the Gymnasium. This System shall include, but not be limited to: amplifiers, mixers, equalizers, speakers, microphones, relays, cabinets, conduits, wiring, etc., as shown on drawings, specified herein and required to form a complete, fully operable sound system.

1.2 SUBMITTALS & MAINTENANCE MANUALS

A. Submittals shall be provided in accordance with Division 1 and as further described herein.

B. Submittals shall include major equipment material lists, summarizing every item to be provided, by manufacturer, part number, quantity and include a brief summary of each item. Manufacturer's product data sheets, describing each of the major components shall also be provided.

C. Submittals shall be tab divided by system to aid in identifying the products associated with each system.

D. Shop drawings shall include complete floor plan drawings showing suggested conduit routing, wire and cable quantities, sizing and routing. A functional block diagram and complete termination diagrams, showing all headend and field device terminations shall also accompany the submittal.

E. Point to point termination charts shall be included, identifying all punch block, panel and intermediate termination points, as well as defining wire and cable color codes and identification schemes to be followed throughout construction.

F. Maintenance Data: For products to include in maintenance manuals specified in Division 1.

1. Descriptions of all equipment and normal operating procedures.
2. Major equipment material lists, summarizing every item to be provided, by manufacturer, part number, quantity and include a brief summary of each item.
3. Manufacturer's product data sheets, describing each of the major components.
4. As-built floor plan drawings showing all installed outlets with label ID's and cabling designation and routing information.
5. Functional block and termination diagrams.
6. Point to point termination charts.
7. Provide warranty information required by manufacturers for submission of warranty claims for all materials installed.

1.3 QUALITY ASSURANCE

A. Electrical Components, devices and accessories shall be listed and labeled for intended use, as defined in NFPA 70, Article 100, by an agency acceptable to the authorities having jurisdiction.

B. Comply with NFPA 70.

C. Comply with UL 50.

1.4 SYSTEM ADJUSTMENTS

A. Final adjustments and settings of sound levels, controls and overall system gain structure shall be accomplished by a factory authorized service representative of the major equipment manufacturer.

1. Up to two on-site assistance visits shall be included as part of the original contract scope of work, to assist the Owner with setup and operation of the System.

1.5 CONFIGURATION:

A. Sound Reinforcement Headend Equipment (amplifiers, controls, etc.) shall be located in storage room 103, near the Gym, as shown on the plans. All equipment shall be housed in suitable, locked equipment cabinet enclosures with hinged doors.

B. Using remote power on/off and volume controls, found in the gym control panel, it shall be possible for the system operator to remotely turn the system on/off and increase/decrease the gain of all microphone and line level audio inputs on a combined (master) basis.

C. System power on/off control shall also be from a switch located on the sound system equipment enclosure.

D. Microphone and line input jacks shall allow live and recorded audio information to be reproduced for distribution over the room’s ceiling speakers.

E. Wireless receiver and associated antennas (located in the room ceiling space) shall receive signals from wireless microphone transmitter and route that audio information to appropriate mixers and distribution amplifiers.

1.6 OPERATION

A. A power amplifier with mixer, equalizer, and miscellaneous controls shall be provided to control the Sound Reinforcement System.

B. The Sound Reinforcement System shall be capable of reproducing and amplifying locally produced audio signals introduced through both hard-wired and wireless microphones, as well as through auxiliary input sources found in these areas.

1. Auxiliary inputs are to be designed to accept signals from tape decks, tuners, CD players, VCR's, etc.
2. Such devices are considered to be outside the scope of the present contract- to be “Owner Furnished” in the future.

C. The System shall accomplish the following:

1. Provide a complete speech reinforcement system for the gymnasium.
2. Provide microphone inputs where shown on plans.
3. Provide auxiliary input jacks where shown on plans.
4. Provide quality microphone and auxiliary mixing.
5. Provide uniform frequency response throughout the room using an equalizer.
6. Provide a Sound System capable of producing 102dB of uniform (+/- 3dB) sound level measured on a calibrated sound meter operating in the "A" weighted range and located in the main seating area of the facility.

D. Wireless receiver and associated antennas (located in the ceiling structure) shall receive signals from wireless microphone transmitter and route that audio information to the mixer.

PART 2 - PRODUCTS

2.1 APPROVALS

A. The Products that are to be provided to form the system described herein are defined both functionally and descriptively. It is to be understood that these explanations are provided to establish minimum acceptable standards of performance and appearance. Product make and model numbers have also been provided to further define and more closely describe specific operational characteristics. Operational features and characteristics which meet or exceed the requirements set forth in this specification are considered equal.

1. All equipment and components necessary for a complete, functioning PA system, capable of operating as described herein, shall be provided.

2.2 EQUIPMENT

A. The Sound Reinforcement System Headend shall be located as noted on plans, and include all equipment necessary for a complete functioning system.

B. Coordinate features to form an integrated system. Match components and interconnections for optimum performance of specified functions.

C. Equipment shall be modular type, using solid-state components, fully rated for continuous duty, unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.

2.3 EQUIPMENT ENCLOSURE

A. The Headend Enclosure shall be an Atlas/Sound Model 320 series, sized for the application and designed for wall mounting, to accommodate all components of the headend. The enclosure shall be of 16 gauge cold rolled steel, with welded seams, finished in textured black enamel and accept standard 19" rack mount modules. Provide a locking front cover. The Wall Enclosure shall be mounted to a 3/4" painted plywood panel and the entire assembly hung in such a manner as to ensure a solid assembly. Provide both blank and vented closure panels to cover all unused rack openings.

B. Provide rack mount shelves to mount Owner provided music sources, as well as miscellaneous sound equipment, patch cords, and accessories. Shelf shall be Middle Atlantic RSH Series, 14" deep. Provide two each 3 rack unit shelves.

C. Provide a Radio Design Labs RC-1U Universal Rack Chassis for mounting miscellaneous control components.

2.4 MIXERS, AMPLIFIERS AND OTHER HEADEND COMPONENTS

A. Mixer-Preamplifiers shall be Bogen CAM8PRO, provided to accept input signals from the various microphone and auxiliary inputs. Mixers shall accept eight (8) inputs; with input sensitivity being field adjustable to accommodate both low impedance balanced microphones and also line level inputs from auxiliary sources. The input preamplifier shall be of discrete transistor design and the inputs shall be differential balanced to ensure low noise and distortion. All inputs shall be transformer isolated. 12-volt phantom power shall be available at each input on a select basis. Front panel trim controls shall have a 40 dB range and rear panel pads of 30 dB shall also be provided for each input. Inputs shall be XLR type. The mixer shall provide a frequency response at +4 dBm of +0, -3 dB between 20 Hz and 20 KHz. THD at +4 dBm shall be less than .1% between 20 Hz and 20 KHz. Hum and Noise on the output shall be less than -85 dBm with master level down.

B. Shure Model DFR22 Digital Signal Processor with built-in 1/3 Octave Graphic Equalizer shall be provided. The equalizer section shall have thirty (30) bands centered on ISO standard frequencies. Each filter will have a slide control providing 12 dB of cut or boost at its center frequency. Filter design shall use constant -Q technology. The equalizer shall also have a switch-able low pass and high pass filter, a + or -12 dB master gain control, and a +18 dB peak indicator. Built-in processing circuitry shall include both compression and hard-limiting control sections. Input and output connectors shall be both XLR and barrier strip type. The Equalizer's frequency response shall be + or -.5 dB at 20 Hz to 20 KHz. THD at +4 dBm and 20 Hz to 20 KHz shall be less than .01%. Noise floor at 30 KHz BW with all filters flat shall be -88 dBu. Maximum output shall be greater than +20 dBu.

C. Power Amplifiers shall be equal to QSC CX series, dual channel design, sized and rated for the application.

1. The amplifiers shall be sized, at a minimum, at 125% of connected load.
2. Output distortion shall be less than .1% THD between 20 to 20,000 Hz and have a frequency response of + or - .2 dB over the same range.
3. The amplifiers shall accommodate various add-on modules, allowing field modifications to be made to suit the application.
4. The amplifiers utilized to drive the distributed loudspeakers shall be rated to accommodate 70V connected speaker load.

D. System operating power shall be switched on and off using a rack mount power supply/surge protectors with momentary remote switch.

E. Provide for remote control of system power and volume in the gym control panel as shown on plans. Remote controls shall co-locate in a 2 gang, decora style, stainless steel cover plate.

1. Provide for remote control of system power as shown on plans and at the equipment enclosure location. Equipment shall include Lowell ACSPR-SCS4-1509 rack mount AC sequencer with surge protection and RPSW2-M lighted rocker switch mounted on single gang blank filler.

2. Provide for remote control of system volume as shown on plans. Equipment shall include Radio Design Labs RU-VCA2 voltage controlled amplifier and Radio Design Labs RLC-2 remote volume control.

F. The block diagram lists a number of pieces of impedance match, splitter and preamplifier signal conditioning devices manufactured by University Sound and Radio Design Labs.

1. These materials and other related pieces shall be furnished as appropriate for the application.
2. Provide all additional power supplies, controls, patch cords, connectors, match transformers, etc., necessary for a complete operating headend & system.

2.5 SPEAKERS

A. Full Range Ceiling Speaker Assemblies shall be Atlas/Sound Series “Q” Loudspeakers:

1. Provide Atlas/Sound Model Q4612, three cubic foot square enclosures with fiberboard and fiberglass insulation and steel shell. Mount the enclosures to the open ceiling structure using “C” Channel (Unistrut) supports. Ensure that enclosures are mounted as high as possible in the steel and clear of all ductwork, lights and other obstructions.
2. Loudspeakers shall be Atlas/Sound Model 12CXT60 type, high compliance, coaxial type, capable of delivering 250 watts of power and with a frequency range from 45Hz to 18,000Hz. Provide with 60 watt transformer & tap at 60 watts each.
3. Grills shall be Atlas/Sound 164-12.
4. Enclosures shall be finish painted on-site and in place, to match the ceiling color.

2.6 OUTLETS, REMOTE CONTROLS AND OTHER COMPONENTS

A. Microphone Outlets shall consist of D3F type microphone sockets attached to appropriate plates for wall or floor mounting as shown on plans.

1. Where wall mounted, plates shall be one gang stainless type.

B. Auxiliary input jacks shall be provided as shown on plans. Auxiliary inputs shall be 1/4" RCA phone type. Where shown to co-locate with mic outlets, both the XLR & ¼” jacks shall share a common plate.

C. Provide an assortment of phono, 1/8”, and 3/32” mini-adaptors to mate the owner’s equipment to the auxiliary jacks. Provide a 20’ patch cord also.

2.7 MICROPHONES AND ACCESSORIES

A. Wireless Microphone Subsystems shall be equal to Shure Series ULX frequency agile, true diversity UHF wireless systems and include the following:

1. Two (2) Receivers (Model ULXS4, site verify proper frequencies).
2. One (1) Antenna Combiner and Power Supply (Model UA844US, support up to 4 receivers).
3. Two (2) ½ Wave Remote Antennas (UA820D with wall mount brackets (UA505).
4. One (1) Belt Pack transmitter (Model ULX1) with batteries.

5. One (1) WL183 Omni-directional Lapel Microphone with clips and cords.
6. One (1) Handheld Wireless Microphone Transmitter (Model ULX2) with SM58 head.
7. Specified wireless transmitters (handheld and beltpack) both use a single switch for on/off and mute/un-mute function, not two switches. Wireless transmitters shall meet this requirement.
8. Remote Antennas shall be wall (or ceiling) mounted where shown on plans and connected to the receivers at the sound rack by coaxial cable run in conduit.
9. All items comprising the complete wireless system shall be set up, tuned and calibrated to ensure quality performance with no outside interference. Frequency selection to be determined on site.

B. Handheld microphones & accessories shall include:

1. One (1) Shure SM58S cardioid microphone, with on-off switch.
2. One (1) Audio Technica AE 5100 condenser microphone, with on-off switch.
3. Two (2) each Atlas-Sound TEB-E tripod microphone stands with tele booms.
4. Two (2) each 25' microphone cords with A series connectors.
5. Two (2) each 50' microphone cords with A series connectors.
6. Two (2) each 20’ Patch Cable, with ¼” mono phone plugs on both ends
7. Two (2) each 20’ Patch Cable, w. (1) ¼” mono plug and (1) 3.5mm stereo plug.

C. Provide all patch cables, couplers and adaptors, as needed to interconnect the wireless receivers and transmitters to the Sound System.

D. Portable Equipment Totes shall be provided to hold all microphones and cords.
1. Totes shall be made of molded plastic and have hinged covers and insert trays. Overall size of tote to be approximately 22”Lx9.5”Wx9.75”H.Totes to be equal to Waterloo Model Number HP2271 (Grainger 2H176).
2. Furnish two (2) Totes to hold mics, cords, wireless equipment, power supplies, etc.

2.8 WIRE AND CABLES

A. Speaker Cable shall be equal to West Penn 228 with (1) twisted, shielded pair, 14-gauge wire. Cable to be Class 2, non-plenum rated.

B. Microphone and Auxiliary Cables shall be equal to West Penn CL2 291 with (1) twisted shielded pair, 22-gauge wire. Cable to be Class 2, non-plenum rated.

C. Coaxial Antenna cable, required for the wireless microphones systems shall be RG58/U type, equal to West Penn 812, and rated for the intended use.

D. Remote Mixer and Control Cables shall be multi-conductor, Class 2 type, suitable for the application, as recommended by the equipment supplier.

2.9 OTHER/ MISCELLANEOUS

A. Custom Labels shall be provided and permanently attached to the amplifier and mixer controls and at all microphone auxiliary outlets, as well as the remote control panel. Labels shall be engraved lamacoid type. Purpose of the Labels is to provide clear, concise identification of each of the inputs and controls. Labels shall clearly identify the intended use of each of the system controls.

1. Mark all control settings with small adhesive “dots”.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The installation shall meet or exceed all applicable National and Local Codes including National Electric Code, State Building Code, etc.

B. All wiring shall be in strict accordance with manufacturer’s wiring diagrams and instructions.

C. All cabling and wiring shall be installed in metal conduit and/or raceway, as elsewhere detailed in specifications and on the plans. All junction boxes and splices shall be tagged and otherwise identified.

D. All devices, including speakers and microphone outlets, shall have final connections made by persons familiar with the trade. Work to be accomplished in craftsman-like manner.

E. All shields shall be maintained whole and unbroken and isolated from ground at all locations except the control headend.

F. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess. Use lacing bars in cabinets.

G. Separate speaker, microphone, line-level and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches for mic level and adjacent parallel power and telephone wiring. Keep cable crosses to a minimum, using right angle crossings, whenever possible.

H. Splices taps and terminations shall be made on numbered terminal strips at all junction, pull, outlet boxes, terminal cabinets and equipment enclosures.

I. Identify conductors and cables by color-coding and applying marking tape to designate wires and cables in accordance with system wiring diagrams.

J. Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 14 AWG and conductors from microphone and line level receptacles to amplifiers not smaller than No. 22 AWG.

3.2 GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal ground termination point shall be the central sound system equipment enclosure, which shall also be grounded by a single #6 AWG conductor to the central electrical bonding point of the building.

3.3 SYSTEM TESTS:

A. Performance Tests shall be conducted by an authorized representative of the equipment manufacturer, to ensure proper installation and to optimize system performance.

1. Tests shall be conducted in accordance with standard industry practices and in a professional manner.
2. Results of all tests shall be recorded and made available to the owner in the O & M Manuals.
3. All settings of controls shall be clearly marked for the owner's use.

B. The following test equipment shall be considered minimum to complete all required tests.

1. Sound Level Meter, Line Impedance Meter, 1/3 Octave analyzer, Sine Wave Generator, Calibrated Microphone, Pink Noise Generator, and a Real Time Spectrum Analyzer.

C. The Installer shall perform the following inspections and tests of the Sound System:

1. Measure and record the impedance of each loudspeaker line before connecting it to the output of its respective amplifier.
2. Measure and record the output impedance of each active device used to terminate passive devices.
3. Measure and record the input impedance of any active device used to terminate passive devices.
4. Measure and record the output of each power amplifier, using as an input source a sine-wave oscillator with less than 1.0 percent THD adjusted to produce 10 dB less than full power output of the amplifier. Inspect the output sine wave appearing on the oscilloscope for complete freedom from hum, noise, parasitic oscillation, and RF interference.
5. Provide complete sound system setup, balance and testing to ensure optimum operation.
6. Verify that all controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings indicating settings of matching transformers.

D. Schedule tests with at least seven days' advance notice of test performance.

3.4 TRAINING/ SYSTEM DEMONSTRATION

A. The Owner's Representative and key staff personnel shall be trained in proper system operation.

1. Training to be conducted by a representative of the equipment supplier, who is familiar with the installation and intended use of the system.
2. Provide training in programming, startup, shutdown, proper operation, troubleshooting and maintenance of the system.
3. Review data in maintenance manuals with Owner’s personnel.

B. A maximum of two (2) training sessions, to last no more than two (2) hours each, shall be conducted prior to occupancy and at a date and time desired by the Owner.

1. Schedule training with Owner, through Architect, with at least seven days' advance notice.

3.5 WARRANTY:

A. The entire installation shall be guaranteed against all defects in materials and workmanship for a period of one (1) year from date of installation.

B. Warranty service shall be provided by a qualified factory-trained representative of the equipment manufacturer during normal working hours, Monday through Friday, excluding holidays. The representative shall be based in a fully staffed sound contracting office, located within a reasonable distance of the job site, and the office shall maintain an adequate supply of normal spare parts.

C. The manufacturer and supplier's Statements of Warranty shall accompany the submittal.

END OF SECTION 277300

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SECTION 277350 – SYNCHRONIZED WIRELESS MASTER-SATELLITE TIME AND BELL SCHEDULING SYSTEM (Washington Elementary School)

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. This Section includes all labor, materials, tools, equipment, and related services to furnish and install a Synchronized Wireless Master-Satellite Time System, as shown on the drawings and specified herein.

B. This Contractor shall furnish, install, and place into operation a complete and operating system, as specified herein. This system shall include, but not be limited to a GPS receiver, wireless master transmitter, software, FCC wireless operating license, wireless tone generator receiver switch, wireless system clocks, bells and power supplies, conduits, cables and wire necessary to form a complete system.

C. There is an existing Sapling Masterclock located at the reception area of the facility. Provided that it accommodates phasing for the project it shall be acceptable to relocate it to the existing penthouse and re-use the masterclock as part of this new system.

1.3 QUALITY ASSURANCE

A. Product Quality
   1. Manufacturer shall specialize in manufacturing commercial time systems with a minimum of 10 continuous years of documented experience.
   2. All basic electronic equipment shall be listed by Underwriter's Laboratories, Inc. for the application and shall be products of manufacturers of established reputation and experience.

B. Contractor Qualifications
   1. The Installing Contractor shall be a firm with documented experience in the installation of commercial time systems.
   2. The Installing Contractor (and any Subcontractors working for the Installing Contractor) shall be licensed, in accordance with local, regional and state authorities having jurisdiction, to complete the work that they are contracted to perform.

1.4 SUBMITTALS, SHOP DRAWINGS & MAINTENANCE MANUALS

A. Submittals shall be provided in accordance with Division 1 and as further described herein.

B. Submittals shall include major equipment material lists, summarizing every item to be provided, by manufacturer, part number, quantity, and include a brief summary of each item.

Manufacturer's product data sheets, describing each of the major components shall also be provided. Submit brochure or color card showing available colors and finishes of clocks.

C. Submittals shall be tab divided to aid in identifying the various sections of the submittal.

D. Shop drawings shall include functional block diagrams and complete termination diagrams, showing all headend, control and typical field devices, shall also accompany the submittal.

E. Manufacturers Instructions: Submit complete installation, set-up, and maintenance manuals.

F. Operators License: Submit evidence of application for operating license prior to installing equipment. Furnish the license, or if the license has not been received, a copy of the application for the license, to the Owner prior to operating the equipment. When the license is received, deliver original license to the owner.

G. Maintenance manuals shall be compiled in accordance with the Division 1, shall include all information provided as part of the original submittal and shall also be updated to include installation notes, manufacturer's manuals, etc. Manuals shall also include:
   1. Descriptions of all equipment and normal operations
   2. Field test reports shall be provided, indicating and interpreting test results for compliance with performance requirements of the Project.
   3. Maintenance data shall be included for all major pieces of equipment, as per the requirements specified in Division 1.
   4. Copy of major equipment manufacturer's standard warranty statements, for future reference and use, should claims need to be submitted.

1.5 SYNCHRONIZED WIRELESS MASTER-SATELLITE TIME SYSTEM DESCRIPTION

A. The system shall provide wireless synchronized precision time that is traceable through GPS satellites to the US Government's official NIST time standard (coordinated universal time).

B. The system shall be a synchronized master-satellite time and bell scheduling system. The system shall synchronize all clocks to each other and utilize GPS technology to provide atomic clock. The system shall not require hard wiring. Clocks shall automatically adjust for daylight savings time.

   1. The wireless transmitter with GPS receiver shall obtain current atomic time from satellite and transmit time to all clocks and tone generators in the system. Clocks shall be synchronized to within 1 second, 6 times per day, and the system shall have an internal oscillator that maintains plus or minus one second per day between synchronizations, so that clock accuracy shall not exceed plus or minus .2 seconds. The transmitter shall operate on FCC licensed frequencies that have good building penetration and that are regulated by the FCC to minimize interference on the selected channel.
   2. The system shall include an internal clock so that failure of the GPS signal shall not cause the clocks to fail in indicating time.
   3. The system shall incorporate fail-safe design so that failure of any component shall not cause failure of the system. Upon restoration of power or repair of failed component, the system shall resume normal operation without the need to reset the system or any component thereof.
   4. Clock locations shall be as indicated, and clocks shall be fully portable, capable of being relocated at any time.

C. The system shall incorporate at wireless tone generator receiver switches to provide a contact closure for sounding class change signals over bells inside the facility and outside of the facility.

1. Timing and operation of the automated bell scheduling system and wireless tone generator system shall be controlled by software provided by system manufacturer, housed in the transmitter and programmed by the master-satellite time system equipment suppliers factory authorized representative. Provide system software for installation on owner furnished PC.
2. Initially and at scheduled intervals, the wireless tone generator shall receive the time data and command packet from the satellite time system transmitter.

1.6 REGULATORY REQUIREMENTS

A. Transmitter and receiver shall comply with Part 15 and Part 90of FCC rules, as follows.

1. The equipment shall not cause harmful interference.
2. The equipment shall not accept interference that will cause adverse effects to equipment operation.
3. The transmittter frequency shall be governed by FCC Part 90.35.
4. The transmitter output power shall be governed by FCC Part 90.257 (b).

B. System shall be installed in compliance with local and state authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver all components to the site in the manufacturer's original packaging. Packaging shall contain manufacturer's name and address, product identification number, and other related information.

B. Store equipment indoors in clean, dry space with uniform temperature to prevent condensation. Protect equipment from weather, dirt, dust, corrosive substances, and physical damage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

2.2 APPROVALS

A. The equipment specified herein is the manufacture of Primex Wireless, N3211 County Road H, Lake Geneva WI 53147, (800)-537-0464. Similar equipment shall be considered for approval, provided the equipment is manufactured of equivalent materials that meet or exceed specified requirements of this sections and requests for approval are received at least seven (7) days prior to bid date and a full explanation of the proposed product substitution is offered.
1. American Time & Signal SiteSync Wireless Clock System is approved as equal for bidding purposes.
2. Sapling (with GPS option) is approved as equal for bidding purposes.

B. Products that are to be provided to form the system described herein are defined both functionally and descriptively. It is to be understood that these explanations are provided to establish minimum acceptable standards of performance and appearance. Product make and model numbers have also been provided to further define and more closely describe specific operational characteristics and/ or to make the contractor aware of the owner's preference for particular products.

1. Systems requiring wiring and/or conduit between master and clocks will not be acceptable.

C. Any exceptions to specifications, in terms of product appearance, configuration, operation or capabilities, which alter a potential bidders ability to meet these specifications shall be fully disclosed to the Architect/ Engineer at the time a request for approval to bid is received.

1. Operational features and characteristics which exceed the requirements set forth in this specification as a minimum standard need not be disclosed at the time of product consideration for approval.

D. Notice of all bidder and product approvals shall be by addendum issued prior to bid date.

2.3 SEQUENCE OF OPERATION

A. Transmitter Operation: When power is first applied to the transmitter, it checks for and displays the software version, then it checks the position of the switches and stores their position in memory. The transmitter then looks for the GPS time signal. Once the transmitter has received the GPS time, it sets its internal clock to that time. The transmitter then starts to transmit its internal time once every second. The transmitter updates its internal clock every time it receives valid time data from the GPS.
1. Transmitter Programming: After the transmitter has been set up and is operating correctly, it is programmed to transmit a signal to the wireless tone generator receiver switch at predetermined intervals. The equipment supplier shall coordinate programming with the owner and provide system training as required in part 3 of this specification.

B. Wireless Tone Generator Receiver Switch Operation: The receiver switch shall receive a signal from the transmitter and generate a contact closure for time synchronization with the Paging Intercom System master clock.

C. Clock Operation:
1. When the batteries are inserted into the clock, pressing the red button as the second hand gets to the 12:00 position will lock the location of the second hand, and the microprocessor will know the location of the second hand. When the red button is pressed as the second hand is passing the hash mark that locks the location of the minute hand in the microprocessor, and the microprocessor will know the location of the minute hand. The microprocessor then assume the location of the hour hand.
2. After the red button has been pressed twice, the microprocessor will start searching the valid time signal channels. If no signal is detected, the receiver will shut off and try again later. If a valid time signal is received, the microprocessor will set the clock to the receive time, then for the next minute, the clock will beep every time that it receives a valid time signal.
3. After initial set, the clock will shut off the receiver. On a pre-scheduled basis, the microprocessor will turn the receiver back on and look for a valid time signal to set the clock.

4. If the clock has not decoded a valid time signal for seven days, then it will go back to the double step mode. Non signal reception can be caused by low battery voltage. If this occurs, replace the clock batteries.

2.4 EQUIPMENT

A. Transmitter: Primex Wireless Model FM-72, consisting of wireless transmitter with GPS receiver. Unit shall obtain current atomic time from satellite and transmit time continuously to all clocks and wireless tone generator receiver switch. Provide multiple transmitters as required to provide a functioning system throughout the facility.

1. Transmission:
   a. Frequency Range: One watt at 72.1 to 72.4 MHz.
   b. Transmission Range: One mile, open field.
   c. Radio Technology: Narrowband FM.
   d. Number of Channels: 16.
   e. Channel Bandwidth: 20KHz maximum.
   f. Transition Mode: One-way communication.
   g. Data Rate: 2 KBps.
   h. Operating Range: 0 degrees Celsius to 70 degrees Celsius.
2. Transmitter:
   a. Frequency Deviation: +/- 4 KHz.
   b. Power Requirements: 120VAC, 60Hz. Provide duplex receptacle at the transmitter location.
   c. Housing Dimensions: Metal, 16-3/4" x 12" x 1-7/8".
   d. Antenna: 46" high, commercial type, mounted on top center of housing. Gain shall be greater than 110 dBm with data logic polarization, 0 to 5 volts.
   e. Transmitter housing shall incorporate a display which shall include the following:
      1) Time readout.
      2) AM and PM indicator if 12 hour time display is set.
      3) Day and date readout.
      4) Indicator for daylight savings or standard time.
      5) Red LED to indicate reception problem.
      6) GPS reception indicator.
   f. Transmitter shall contain an internal clock such that failure of reception from the GPS will not disable the system operation.
   g. Power supply shall be model number Q11666, 120V, 60Hz, .4A input with 9VDC, 1.5 amp output.
   h. Transmitter shall have 16 selectable channels to assure interference-free reception.
   i. Transmitter shall have the following switches:
      1) Time zone adjust switches for all US time zones: Eastern, Central, Mountain, Pacific, Alaska and Hawaii.
      2) Daylight saving time bypass switch.
      3) 12-hour or 24-hour display.

B. GPS Receiver: Primex Model Q11722, GPS roof mounted with Primex Wireless coaxial cable of length required to route to the receiver location. Cabling shall be installed in raceway.

1. The receiver shall be enclosed in a weatherproof case, 3-7/8" x 4-13/16" x 2", designed for roof mounting. Provide mounting bracket for attachment to roof structure.

C. Wireless Tone Generator Receiver Switch: Primex Model 14002, complete with cables and antenna required for complete installation. The receiver switch shall receive a signal from the

transmitter and generate a contact closure for time synchronization with the Paging Intercom System master clock.

1. Housing: Plastic, 7-1/4" x 5" x 1-1/2".
2. Power Requirements: 120VAC, 60Hz. Provide duplex receptacle at the tone generator receiver switch location.
3. Features:
    a. Switching Contacts: Form D, two sets, one normally open and one normally closed.
        1) Ratings: 5A, 1/6hp, 250VAC or 5A, 20 VDC.
    b. Test and reset buttons.
    c. Signal indicator.
    d. Switch identification codes.
    e. 16 selectable channels.
    f. 24 programmable events with 7 day selectable operations. Selectable options for each event as follows:
        1) None.
        2) Turn on and stay on.
        3) Turn on for one second, then offo for one second, repeat 5 times.
        4) Turn on for 3 seconds.
        5) Turn on for 5 seconds.
        6) Selectable daylight saving time bypass.
        7) Selectable automatic channel scanning.
    g. Switch shall be computer programmable through transmitter with automatic backup, and schedule changes easy to make.
    h. Switching information shall be stored in non-volatile memory in the transmitter and broadcast at regulat intervals. Each switch retains its instructions in non-volatile memory.
    i. Receiver switch shall be factory preset with channel I.D. # 1, Switch #00, and volume of 50%.

D. Software: Primex Model 14003 scheduler software for installation on owner furnished PC. The manufacturer's factory authorized representative shall coordinate PC system requirements and provision with the owner. Programming shall be accomplished by the factory authorized representative.

1. Software shall be in the form of a CD, suitable for operation in standard CD-ROM drives.
2. Provide one cable, RS232 with USB-to-serial adapter if required for use in downloading programmed software to the wireless tone generator switch.

E. Clocks: Primex wireless clocks. 12-1/2" diameter or 16" diameter (in gymnasiums and other areas as indicated on the plans), polycarbonate frame and lens, white face, black hour and minute hands, red sweep second hand, with frame color and finish as selected from manufacturer's standard colors and finishes. Clocks shall be double faced where noted on the plans.
1. Clocks shall be battery operated, and shall have a 5 year battery life. Provide 2 alkaline "D" cell batteries with each clock.
2. Clocks shall be capable of automatically adjusting for daylight savings time. An on-off switch located on the transmitter shall disable this function if desired.
3. Time shall be automatically updated from the transmitter 6 times per day via an internal antenna. If the transmitter stops transmitting valid time signals due to power failure, the clocks shall continue to function as accurate quartz clocks until a valid time signal is decoded.

4. Clocks shall remember the time during changing of batteries.

F. Wire Guards: Provide wire guards for clocks located in gymnasiums and other areas as indicated on the plans. Wire guards shall be painted to match the finish of the surface to which they are mounted.
   1. Guards for 12-1/2" clocks shall be Primex Model 14131, 14" x 14".
   2. Guards for 16" clocks shall be Primex Model 14123, 18" x 18".

G. Automated Bell Scheduling System shall allow the setup and management of bell schedules. System shall manage and monitor the bell schedules and the synchronization with clocks.
   1. Network-enabled relays shall be provided so that the bells on the building exterior are on a separate schedule from interior bells.

H. Class change bells shall be provided where shown on prints (i.e.: outdoors, corridors, gymnasium, cafeteria, and other high noise areas).

   1. Bells shall be mechanical, vibrating type to operate at 24VAC, equal to Wheelock 43T-G6-24-S and operate at 24VAC. Provide WBB-S backbox as required.

I. Low voltage power transformers shall be furnished to operate all bells. These transformers shall operate at 24VAC and be sized to handle the entire connected bell load PLUS have 40% spare capacity as a MINIMUM. Transformers shall be equal to GE BT24-1000 series, or larger as required.

J. Bell Cabling: Cabling shall be as recommended by the manufacturer's representative, #14 AWG minimum conductor size. Plenum rated cabling with overall jacket is acceptable if installed in accordance with article 3 of this specification.

K. Cable Connection Sealant: Radio Shack CoaxialCable Connector Sealant 278-1645, or approved silicone sealant.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that construction is near completion in spaces to receive equipment ant that rooms are clean and dry.

B. Verify that 120V receptacles are located within 6' of the transmitter and tone generator switch locations, and that the outlets are operational and properly grounded.

C. Verify that a compatible PC is available for dedicated use during software installation and system testing.

3.2 INSTALLATION

A. The installation shall be in accordance with the latest requirements of the NEC, State, and Local Codes, ordinances and regulations of any other governing body having jurisdiction

B. All equipment shall be installed in a neat and workmanlike manner and to the satisfaction of the Project Engineer.

C. Install GPS receiver unit on roof in location indicated, in clear view of the sky. Install unit in location free from standing water, and above accumulations of leave or debris. Seal coaxial cable connection to GPS with cable connection sealant. Coordinate installation with roof work so that the bracket and related fasteners are watertight.

D. Locate the transmitter where indicated, a minimum of 3 feet above the floor, away from large metal objects such as filing cabinets, lockers, or metal framed walls.
   1. Attach the GPS receiver to the transmitter using coaxial cable.
   2. Connect the antenna to transmitter, using care not to strip threads.
   3. Connect power supply to the transmitter.
   4. Set the channel number on the display to correspond to the FCC license.
   5. Plug the power supply into electrical outlet.

E. Install the wireless tone generator receiver switch in location indicated, and secure to base using fasteners of type recommended by the manufacturer, and suitable for the surface to which it is attached.
   1. Align the antenna vertically.
   2. Verify that the factory switch settings as specified above are correct. If changes are required due to field conditions, perform the following:
      a. Remove receiver dip switch covers for access to the selector switches.
      b. Verify that the channel selector matches the selected channel on the transmitter.
      c. Set the dip switches as required for daylight savings time adjustment.
      d. Press the "reset" buytton to effect any changes in settings.
   3. Connect the relay output to the Paging Intercom System master clock.
   4. Confirm that the green LED is flashing, to indicate that the generator is receiving a signal from the transmitter.

F. Install the clocks at locations indicated on the plans. Clocks shall not be installed until painting and other finish work in each room is complete.
   1. Install "D" cell batteries.
   2. Set clock to correct time in accordance with manufacturer's instructions.
   3. Observe clock until valid signals are received and clock adjusts itself to correct time.
   4. Install the clock on the wall in the indicated location, plumb, level, and tight against the wall. Attach using Clock-Lock hanging method and suitable fasteners as approved by clock manufacturer.
   5. Where wire guards are provided, attach guards secure to the wall, using approved theft-resistant fasteners..

G. Install cable without damaging conductors, shield, or jacket.

H. Pull cables without exceeding cable manufacturer's recommended pulling tensions.

   1. Pull cables simultaneously if more than one is being installed in the same raceway.
   2. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation.
   3. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage media or raceway.

I. Use splice and tap connectors compatible with media types.

J. Bell Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, counters, accessible lay-in tile ceiling spaces, and in gypsum board partitions where "free air" cable wiring method may be used. Use UL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and wiring except in unfinished spaces. All cabling routed at exposed ceiling structure in finished spaces shall be installed in raceway. All wiring installed underground or underslab shall be wet location listed.

1. Where cable is run "free air" in accessible lay-in tile ceiling spaces, the cable shall be rated for the intended use and shall be neatly run and supported, using acceptable means to ensure reliable installation and performance.

    a. Install exposed cable parallel and perpendicular to surfaces or exposed structural members, and follow surface contours where possible.
    b. Install sleeves for cable penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls. Provide insulated bushings for protection of conductors.
    c. Secure and support cable at intervals not exceeding 8 feet and not more than 12 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
    d. Utilize cable distribution rings and hangers, standoffs, spools and other suitable devices as an aid in managing all cable runs. Cable distribution rings or hangers shall be wall or ceiling mounted above accessible corridor ceilings at 8-foot intervals.
    e. Cables shall not be laid on or draped across any ceiling tiles, grids, electrical or mechanical fixtures. Maintain at least a 12 inch separation between the communications cables and fluorescent or HID lighting.
    f. Cables shall not be strapped, taped, or attached by any means to the exterior of any conduit or raceway as a means of support.
2. Install cable without damaging conductors, shield, or jacket.
3. Pull cables without exceeding cable manufacturer's recommended pulling tensions.
    a. Pull cables simultaneously if more than one is being installed in the same raceway.
    b. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation.
    c. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage media or raceway.
4. Make splices, taps, and terminations only at indicated outlets, terminals, and cross-connect and patch panels.
5. Use splice and tap connectors compatible with media types.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory authorized representative to inspect field-assembled components and equipment installations, including connections.
1. Program the scheduler software for time synchronization of this system with the Paging Intercom System master. Coordinate requirements with the Paging Intercom System equipment supplier.

3.4 TESTING

A. The System shall be tested, prior to acceptance, by a factory authorized representative of the manufacturer, at a time designated by the Architect/Engineer or owner. Manufacturer's representative shall provide a letter detailing the date and scope of all tests conducted and shall certify in writing that all tests have been performed and that results of these tests are satisfactory.

B. General testing:

1. Visually inspect all system components for correct operation. Replace all parts which are found to be defective.

3.5 CLEANING

A. Prior to final acceptance, clean exposed surfaces of all system components using cleaning methods recommended by the manufacturer. Remove temporary labels from clock faces. Do not remove labels from backs of clocks.

B. Protect finished installation until final acceptance of the system.

3.6 TRAINING

A. The owner’s representative and key staff personnel shall be trained in proper operation of the system.

B. Training is to be conducted by a factory authorized representative, who is familiar with the installation and the intended use of the system.

C. The contractor shall provide a minimum of one training session, to last no more than two (2) hours, prior to final acceptance of the system, at a date and time desired by the owner.

D. Separate maintenance type training sessions shall be conducted to familiarize the owner’s maintenance staff with routine maintenance and field programming features of the system. A minimum of two (2) hours of training shall be provided.

3.7 WARRANTY

A. The entire installation shall be guaranteed against all defects in materials and workmanship for a period of one (1) year from date of installation & final acceptance. Factory-trained personnel, employed by the equipment supplier, shall provide first response to a problem during the warranty year. This response is to include maintenance, repair, or replacement of any equipment found to be defective, provided the defect is not caused by misuse, abuse, neglect, or unauthorized tampering or modification. All labor, shipping, transportation and related expenses are to be at no additional cost to the owner for any guarantee service provided.

END OF SECTION 277350

SECTION 277400 - COMMUNICATION AND DATA-PROCESSING EQUIPMENT

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 wire, cable, connecting devices, installation, and testing for wiring systems to be used as signal pathways for voice and high-speed data transmission.

B. The data transmission system shall be a Manufacturer Certified Category 5e system as specified and indicated on the drawings. Warranty shall be a minimum of fifteen years.
   1. The cable shall have guaranteed performance measurements out to 350MHz for all categories except ARC which needs to be measured up to 200MHz. These guaranteed measurements need to be equal to or better than Mohawk Megalan Category 5E+.
   2. The system shall incorporate commercial grade products as specified. Lead frame and residential grade products are not acceptable.

C. This contractor shall be responsible for the removal and legal disposal of all abandoned communications cabling and devices.

1.3 SUBMITTALS

A. Submittals shall be provided in accordance with Division 1 and as further described herein.

B. Submittals shall include major equipment material lists, summarizing every item to be provided, by manufacturer, part number, quantity, and include a brief summary of each item. Manufacturer’s product data sheets, describing each of the major components shall also be provided.

C. Submittals shall be tab divided by system to aid in identifying the products associated with each system.

D. Shop Drawings: Include dimensioned plan and elevation views of components. Show access and workspace requirements.

   1. System labeling schedules, including electronic copy of labeling schedules, as specified in Part 3, in software and format selected by Owner.

E. Maintenance Data: For products to include in maintenance manuals specified in Division 1.

   1. Descriptions of all equipment and normal operating procedures.
   2. Provide as-built floor plan drawings showing all installed outlets with label ID’s and cabling designation and routing information.

3. Provide warranty information required by manufacturers for submission of warranty claims for all materials installed.
4. Include a complete proof of performance report outlining the operating parameters tested, complete test results and a review of industry standards for each parameter. One copy of test results in electronic format accompanied with the software from the test equipment manufacturer to view and update test results must also be included.
5. Include proof of calibration for all copper and fiber test equipment.

1.4 QUALITY ASSURANCE

A. This contractor shall be a firm that specializes in this type of work and shall, upon request, provide documentation of a minimum of three other successfully completed projects of similar size and magnitude that they are responsible for completing.

B. On the date of document issue, this contractor shall be a certified installer by:

1. AMP, Inc.
2. CommScope, Inc.
3. Hubbell Premise Wiring, Inc.
4. ADC/Krone, Inc.
5. Leviton Network Solutions.
6. Optical Cable Corporation.
7. Ortronics, Inc.
8. Panduit Corporation, Network Systems Division.
9. Siemon Company.
10. Signamax Connectivity Systems.

C. This contractor and all employees working on the jobsite shall currently meet all manufacturer's requirements for the provision of all equipment specified herein. This contractor shall provide certification that all assigned staff have attended training courses corresponding to the types of cabling and installations specified herein.

D. This contractor shall be familiar with and utilize the following reference documents and codes throughout the course of equipment installation.

1. ANSI/TIA/EIA-568-B.1 Commercial Building Telecommunications Cabling Standard and all addendums.
2. ANSI/TIA/EIA-568-B.2 Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted-Pair Cabling Components and all addendums.
3. ANSI/TIA/EIA-568-B.3 Commercial Building Telecommunications Cabling Standard Part 3: Optical Fiber Cabling Components Standard and all addendums.
4. ANSI/TIA/EIA-569-A Commercial Building Standard for Telecommunications Pathways and Spaces.
5. ANSI/TIA/EIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
6. BICSI Telecommunications Distribution Methods Manual, most recent edition.
7. BICSI Telecommunications Cabling Installation Manual, most recent edition.
8. NFPA-70 National Electrical Code, most recent adopted edition.
9. NECA/BICSI-568-A Standard for Installing Commercial Building Telecommunications Cabling.
10. Federal Communications Commission Part 15 and Part 68.
11. UL 444 – Standard for Safety of Communications Cable.

12. UL 1666 – Standard for Safety of Flame Propagation Height.
13. NFPA 262 – Flame Travel and Smoke of Wires and Cables.
14. Any additional requirements of the Local Authority Having Jurisdiction.

E. This contractor shall utilize and have operators trained in the utilization of the following test equipment:

1. Copper Cable Test Equipment

a. Fluke DTX 1800, or approved equal.

F. All products provided as part of this project shall be manufactured by firms experienced in manufacturing components listed under ANSI/TIA/EIA 568-B.2 and whose products conform to the standards of this specification.

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

1.5 COORDINATION

A. Coordinate Work of this Section with Owner's telephone switch, telephone instrument, workstation, and LAN equipment suppliers. Coordinate service entrance arrangement with local exchange carrier.

1. Meet jointly with representatives of above organizations and Owner's representatives to exchange information and agree on details of equipment arrangements and installation interfaces.
2. Record agreements reached in meetings and distribute record to other participants.
3. Adjust arrangements and locations of distribution frames, patch panels, and cross connects in equipment rooms and wiring closets to accommodate and optimize arrangement and space requirements of the telephone switch and LAN equipment.

1.6 MAINTENANCE/WARRANTY

A. Provide service and maintenance of cabling system for one year from date of substantial completion.

B. Provide a warranty for the system (including complete horizontal channels) against malfunction due to component failure or improper installation for a period of fifteen years from date of substantial completion. When notified of a malfunction, proceed to immediately correct the situation by replacement of repair, without cost to the Owner. Clearly indicate provisions of the warranty in the shop drawing submittals and maintenance manuals.

C. Within the warranty period, the contractor shall repair or replace any defective system components within 48 hours.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Cable products:

a. Belden Wire & Cable Company.
b. Berk-Tek, Inc.
c. CommScope, Inc.
d. General Cable.
e. Hitachi Cable Manchester.
f. Mohawk/CDT.
g. Optical Cable Corporation.
h. Corning.
i. Superior Essex.

2. Connectors, distribution racks, modular jacks, wall plates, patch panels, cable management products, etc. shall be to the greatest extent possible, of one of the following manufacturers:

a. Allen Tel Products, Inc.
b. AMP, Inc.
c. CommScope, Inc.
d. Great Lakes Case & Cabinet Company, Inc.
e. Hoffman.
f. Hubbell Premise Wiring, Inc.
g. Leviton Network Solutions.
h. Optical Cable Corporation.
i. Ortronics, Inc.
j. Panduit Corporation, Network Systems Division.
k. Siemon Company.
l. Signamax Connectivity Systems.
m. Superior Modular Products.

2.2 SYSTEM REQUIREMENTS

A. General: Coordinate the features of materials and equipment so they form an integrated system. Match components and interconnections for optimum future performance.

B. Expansion Capability: Unless otherwise indicated, all patch panels, cross connects, terminal strips, trays, wireways, equipment racks, etc. shall be sized to accommodate 20 percent future increase in active workstations.

2.3 MOUNTING ELEMENTS

A. Raceways and Boxes: Comply with Division 16 Section "Raceways and Boxes."

B. Backboards: 3/4-inch (19-mm) interior-grade, fire-resistive-treated plywood.

C. Distribution Racks: Freestanding, as appropriate for the application, and be modular-steel units designed specifically for attachment of telecommunications terminal support equipment.

1. Racks shall be designed to accommodate TIA/EIA standard rack mount equipment.
2. Free standing racks shall be approximately 78 inches high by 19 inches wide. Finish in black powder coat baked finish
3. Provide vertical (front and rear on each side of rack extending from floor to top of rack) and horizontal (2 rack space unit between each patch panel) cable management channels.

2.4 WIRE MANAGEMENT

A. Jumper Troughs:

1. Furnish and install 110 jumper troughs for management of terminal block patch cords and jumper wires, two per terminal block.

B. Patch Cord Organizer:

1. Furnish and install 110 patch cord organizers for management of terminal block patch cords and jumper wires, two per patch panel.

C. Wire Distribution Spools:

1. Furnish and install wire distribution spools for management of terminal block jumper wires, quantities as required.

D. Wire Hanger Assembly:

1. Furnish and install wire hanger assemblies for management of patch cables, four per backboard.

E. Cable Hangers:

1. Furnish and install “j-hook” cable hangers that are a minimum of one inch wide and be spaced no more than four feet on center.

2.5 COPPER CONNECTS AND TERMINAL EQUIPMENT

A. Patch panels (data and voice terminations) shall be modular and designed to accommodate the mounting of multiple numbered jack units. Connectors of the category 5e IDC type, at each jack, are to be used to terminate all wires of each arriving cable. Provide a jack for every arriving cable, plus spares as elsewhere required.

1. Mounting: Rack. Mount above eye level.

B. Jacks and jack assemblies for UTP cables shall be category 5e jack modules, modular, color coded, RJ45 type receptacles, with integral IDC type terminals (clips).

1. Jacks shall conform to the performance standard set for in EIA standards and shall have been tested in accordance with TIA/EIA 568-B.2 standard. Jacks shall be durable enough to withstand 2,500 (minimum) insertions and withdrawals of a mating plug, without jack failure or degradation of the connection, as defined in IEC 603-7.

C. Patch panel patch cords shall be category 5e, 4 pair cables in required lengths, not to exceed 5 meters in length, and shall be of the same manufacturer as other connectivity components in the system. Furnish as UTP and STP, as required. Plug connectors must be designed to properly mate with the jacks being installed. Provide one patch cord for every patch panel data jack in the facility.

D. Workstation patch cords shall be category 5e 4 pair cables in 2, 3, and 4 meter lengths, and shall be of the same manufacturer as other connectivity components in the system. Furnish as UTP and STP, as required. Plug connectors must be designed to properly mate with the jacks being installed. Provide one patch cord for every communications outlet in the facility. Provide equal number of 2, 3, and 4 meter length cords.

E. Communications outlets (as designated by a half filled/half open triangle on the drawings) shall consist of multi jack/connector assemblies mounted in single gang faceplates. Outlets shall be equal to Siemons CT4 series plastic faceplates in gray finish with designation labels and covers, provide space for two couplers. Couplers shall be equal to Siemons CT series angled coupler assemblies in gray finish (flat couplers shall be used for communications outlets located in ceilings and floor boxes). Unless noted otherwise on the plans, all communications outlets shall be equipped with a category 5e double jack coupler, equal to Siemons CT-5e series, with two data cables (2D) and a blank filler coupler. Cables shall be routed to the new IDF location.

1. Typical Legend: Factory label top left jack (gray), "Data"; top right jack (gray), “Data”; bottom left jack (if required) (blue), “Voice”; bottom left jack (if required) (gray, blue, or red), “Data”, Voice”, or “Fax” as required for the application.

2.6 UTP/STP COPPER CABLES

A. All voice and data communications cables shall be listed in compliance with enhanced category 5e TIA/EIA-568-B.1 standards. All voice and data cables shall be category 5e extended frequency (350 MHz) type. Manufacturer’s test results shall certify compliance with this standard.
1. Cables shall be blue.

B. Conductors shall all be of solid copper.

C. Unshielded Twisted Pair (UTP) Cable shall be multipair, 24 ga., color coded, thermoplastic-insulated conductors in a PVC jacket.

D. Where required to comply with building and life safety codes, cables shall be rated for use in a Plenum environment. Features to remain as previously described, except that jacket materials are to be modified to attain the proper listing for the cable.

E. Provide 4 pair category 5e cables for all data and voice runs to communications outlets.

F. Provide 25 pair cat 5e cables between MDF and IDF’s as indicated on the drawings.

2.7 IDENTIFICATION PRODUCTS

A. Comply with Division 16 Section "Basic Electrical Materials and Methods" and the following:

1. Cable Labels: Self-adhesive vinyl or vinyl-cloth wraparound tape markers, machine printed with alphanumeric cable designations.
2. Machine generated labels shall likewise be applied to all faceplates, patch panels, and other locations, as appropriate.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for cable. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CABLE APPLICATION

A. Data Backbone UTP Cable: Category 5e, 4 pair minimum, to be used in runs between equipment rooms and wiring closets (ie: MDF & IDF locations).

B. Voice Backbone UTP Cable: Category 5e, 25 pair minimum, to run between equipment rooms and wiring closets.

C. Data UTP Cable for Horizontal Runs: Category 5e, 4 pair minimum, to be used in runs from communications outlets to wiring closets.

3.3 INSTALLATION

A. The installation shall be in accordance with the latest requirements of the NEC, State, and Local Codes, ordinances and regulations of any other governing body having jurisdiction along with meeting BICSI standards.

B. All equipment shall be installed in a neat and workmanlike manner and to the satisfaction of the Project Engineer.

C. Communications outlet raceway shall consist of 4” square backbox, single gang ring, and ¾” (minimum) conduit with insulated bushing to accessible ceiling space unless noted otherwise.

D. Wiring Method: Install wiring in raceway and cable tray (where provided) except within consoles, cabinets, desks, counters, accessible ceiling spaces, and in gypsum board partitions where “free air” cable wiring method may be used. Use UL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and wiring except in unfinished spaces. Where cabling cannot be installed in finished spaces, cables shall be installed in surface steel wiremold (or multi-outlet assembly if cable counts dictate). All cabling installed underground or underslab shall be wet location listed.

1. Whether system cabling is installed in cable tray or “free air”, the system cabling shall be neatly run and shall be bundled separately from all other systems cabling.

2. Where cable is run “free air”, the cable shall be rated for the intended use and shall be neatly run and supported, using acceptable means to ensure reliable installation and performance.
   a. Install cable parallel and perpendicular to surfaces or exposed structural members, and follow surface contours where possible.
   b. Install sleeves for cable penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls. Provide insulated bushings for protection of conductors.
   c. Secure and support cable at intervals not exceeding 4 feet and not more than 12 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   d. Utilize cable distribution rings and hangers, standoffs, spools and other suitable devices as an aid in managing all cable runs. Where cable tray is not provided, cable distribution hangers shall be wall or ceiling mounted above accessible ceilings at varying 4 to 6 foot intervals. All cable hangers shall be self supporting and be attached to building structure.
   e. Cables shall not be laid on or draped across any ceiling tiles, grids, electrical or mechanical fixtures, raceways, piping, or ductwork. Maintain at least a 12 inch separation between the communications cables and fluorescent or HID lighting.
   f. Cables shall not be strapped, taped, or attached by any means to the exterior of any conduit or raceway as a means of support.
   g. Tie-wraps are not approved, where extra supports are needed for cable support, utilize Velcro strapping.

E. Install cable using techniques, practices, and methods that are consistent with Category 5e rating of components and that ensure category 5e performance of completed and linked signal paths, end to end.

F. Install cable without damaging conductors, shield, or jacket.

G. Do not bend cable in handling or in installing to smaller radii than minimums recommended by manufacturer.

H. Pull cables without exceeding cable manufacturer's recommended pulling tensions.

1. Pull cables simultaneously if more than one is being installed in the same raceway.
2. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation.
3. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage media or raceway.

I. Cable Slack: Provide additional slack at both ends of cables to accommodate future cabling system changes. Include the slack length in all length calculations to ensure that horizontal cable does not exceed 295’.

1. Do not store slack cables in bundled loops. Store cable slack in an extended loop or in a figure 8 configuration to alleviate stress.
   a. The minimum amount of slack at the MDF and IDF locations shall be 10’.
   b. The minimum amount of slack at communications outlet locations shall be 1’.

J. Wiring within Wiring Closets: Provide adequate length of conductors. Train conductors to terminal points with no excess. Use lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.

K. Make splices, taps, and terminations only at indicated outlets, terminals, and cross-connect and patch panels.

L. Use splice and tap connectors compatible with media types.

3.4 GROUNDING

A. Comply with Division 16 Section "Grounding."

B. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

C. To ensure proper grounding, a separate, green #6 copper stranded wire shall be provided & extend from the main distribution frame (MDF) to all intermediate distribution frames (IDF) and all other wiring closets back to the main electrical service entrance central ground reference location. Grounding and bonding shall conform to requirements and TIA/EIA-607 standard.

D. A ground buss bar shall be installed in each MDF and IDF. It shall have insulated standoffs and be pre-drilled with an array of ¼” holes. The MDF’s buss bar size shall be ¼” x 4” x 14” and the IDF bus bars shall be ¼” x 2” x 7”. All connections to the buss bars shall be made via non-reversible crimp style one or two hole connectors.

3.5 INSTALLATION IN EQUIPMENT ROOMS AND WIRING CLOSETS

A. Line walls with ¾” plywood backboards. Paint backboards with two coats of grey fire retardant paint.

B. Mount patch panels, terminal strips, connecting hardware, and cable management equipment on backboards, unless otherwise indicated.

C. Group connecting hardware for cables into separate logical fields.

D. Use patch panels to terminate data cables entering the space, unless otherwise indicated.

3.6 IDENTIFICATION

A. Identify system components complying with applicable requirements in Division 16 Section "Basic Electrical Materials and Methods" TIA/EIA-606 standard, and the following specifications.

B. System (verify with owner): Use a unique, three-syllable alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.

1. First character identifies and locates wiring closet or equipment room where cable originates.

2. Second character identifies and locates cross-connect or patch-panel field in which cable terminates.
3. Third character designates the position occupied by the cable (and its pairs) in the field.
4. Subsequent characters to further describe the cable routing and destination, as deemed necessary.

C. Communications Outlet: Label jacks within outlets and cables within outlet boxes.

D. Distribution Racks and Frames: Label each unit and field within that unit.

E. Within Connector Fields, in Wiring Closets and Equipment Rooms: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both communication and data-processing equipment, use a different color for jacks and plugs of each service.

F. Cables, General: Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.

G. Cable Schedule: Post in prominent location in each wiring closet and equipment room. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Provide electronic copy of final comprehensive schedules for Project, in software and format selected by Owner.

3.7 FIELD QUALITY CONTROL

A. Testing: On installation of cable and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed.

B. Test Reports shall be generated utilizing the compilation software provided as part of the test equipment package routinely included with current data communications test equipment.

C. Correct malfunctioning units at the Project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

D. Test Equipment Criteria:

1. All category 5e field testing shall be performed with an approved level IV UTP/ScTP field test device.
2. All UTP/ScTP field testers shall be factory calibrated each calendar year by the field test equipment manufacturer as stipulated by the manuals provided with the field test unit. The calibration certificate shall be provided for review prior to the start of testing.
3. Autotest settings provided in the field tester for testing the installed cabling shall be set to the default parameters.
4. Test settings selected from options provided in the field testers shall be compatible with the installed cable under test.

E. Copper Cable Testing:

1. Category 5e Data and Voice Cable:

a. Category 5e UTP/ScTP horizontal and backbone cables, whose length does not exceed 90 m (295 ft) for the permanent link, and 100 m (328 ft) for the channel shall be 100% tested according to ANSI/TIA/EIA-568-B.1.
b. Test parameters include wire map plus ScTP shield (when present) continuity, length, NEXT loss (pair to pair), NEXT loss (power sum), ELFEXT loss (pair to pair), ELFEXT loss (power sum), return loss, insertion loss, propagation delay, and delay skew.
c. All UTP/ScTP backbone cables exceeding 90 meters shall be 100% tested for continuity.
d. All installed channels shall perform equal to or better than the minimum requirements as specified below at the highest frequency:
    1) Frequency Range: 1-100MHz
    2) Insertion Loss: 24 dB
    3) NEXT Loss: 30.1 dB
    4) Power Sum NEXT Loss: 27.1 dB
    5) ELFEXT: 17.4 dB
    6) Power Sum ELFEXT: 14.4 dB
    7) Return Loss: 10.0 dB
    8) Propagation Delay: 548 ns
    9) Delay Skew: 50 ns
    10) ACR: 6.1 dB
    11) Power Sum ACR: 3.1 dB

3.8 ACCEPTANCE REQUIREMENTS

A. The contractor must warrant in writing that 100% of the installation meets the requirements specified.

B. The owner reserves the right to conduct, using contractor equipment and labor, a random re-test of up to 5% of the cable plant to confirm documented results. Any failing cabling shall be re-tested and restored to a passing condition. In the event more than 2% of the cable plant fails during re-test, the entire cable plant shall be re-tested and restored to a passing condition at no additional cost to the owner.

C. Acceptance shall be subject to completion of all work, successful post-installation testing which yields 100% PASS rating, and receipt of full documentation as described in this specification.

3.9 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.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain systems.

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.

2. Train designated personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and extending wiring to establish new workstation outlets. Provide a minimum of two hours training.
3. Review data in maintenance manuals. Include copies of all field tests and results. Test results shall show every termination point by identification number and list results of all tests performed. Identify every jack and outlet by name, cable ID, patch panel and crosspoint ID, as well as a description of the building location where the jack is located.
4. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION 277400

SECTION 287210 - FIRE ALARM SYSTEM (Washington Elementary)

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 fire alarm systems with manual stations, detectors, signal equipment, controls, and devices.

1.3 SYSTEM DESCRIPTION

A. General: The entire existing EST conventional fire alarm system shall be removed.

B. General: The new system shall be a noncoded, addressable system with manual and automatic alarm initiation; and multiplexed signal transmission dedicated to fire alarm service only.

C. Wiring Class and Style: Initiating device circuits and signaling line circuits shall be Class B.

1.4 SUBMITTALS, SHOP DRAWINGS & MAINTENANCE MANUALS

A. Submittals shall be provided in accordance with Division 1 and as further described herein.

B. Submittals shall include major equipment material lists, summarizing every item to be provided, by manufacturer, part number, quantity, and include a brief summary of each item. Manufacturer’s product data sheets, describing each of the major components shall also be provided.

C. Submittals shall be tab divided to aid in identifying the various sections of the submittal.

D. Shop drawings shall include complete floor plan drawings showing device locations, conduit routing, wire and cable quantity and sizes. Functional block diagrams, complete termination diagrams, showing all headend, control and typical field devices, shall also accompany the submittal.
   1. Battery: Provide battery sizing calculations for the control panel and each power expander for actual connected loads.
   2. Voltage Drop Calculations: Provide voltage drop calculations for all notification circuits.
   3. System Operation Description: Detailed description for this Project, including method of operation and supervision of each type of circuit and sequence of operations for manually and automatically initiated system inputs and outputs. Manufacturer’s standard descriptions for generic systems are not acceptable.

E. Maintenance manuals shall be compiled in accordance with the Division 1, shall include all information provided as part of the original submittal and shall also be updated to include installation notes, manufacturer's manuals, etc. Manuals shall also include:
   1. Descriptions of all equipment and normal operating procedures.
   2. Final shop drawings, updated to reflect "as-built" accuracy. Include outlets with label ID's, and cable designations and routing information.
   3. Field test reports shall be provided, indicating and interpreting test results for compliance with performance requirements of the Project. Provide certificate of completion in compliance with NFPA 72.
   4. Maintenance data shall be included for all major pieces of equipment, as per the requirements specified in Division 1.
   5. Copy of major equipment manufacturer's standard warranty statements, for future reference and use, should claims need to be submitted.

F. Submissions to Authorities Having Jurisdiction: In addition to distribution requirements for Submittals specified in Division 1 Section "Submittals", make an identical submission (quantity as required by the AHJ) to authorities having jurisdiction. Include copies of annotated Contract Drawings as needed to depict component locations to facilitate review. Resubmit if required to make clarifications or revisions to obtain approval. On receipt of comments from authorities having jurisdiction, submit them to Architect for review.

1.5 QUALITY ASSURANCE

A. Product Quality
   1. Equipment described in this Section shall be provided by a company regularly engaged in the design, sale and installation of Fire Alarm Systems. This company shall also have a service organization, trained by the equipment manufacturer and located a reasonable distance from the jobsite, which is capable of maintaining the system once installed. The services of this company shall be retained by the Electrical Contractor to supervise the system design, installation, make final system connections, and perform all tests and balance work required.
   2. All basic electronic equipment shall be listed by Underwriter's Laboratories, Inc. for the application and shall be products of manufacturers of established reputation and experience.
   3. Obtain fire alarm system components through one source from a single manufacturer.

B. Contractor Qualifications
   1. The Installing Contractor shall be a firm specializing in the type of work called out in this specification section and shall, upon request, provide documentation that they have successfully completed at least three other installations of similar size and scope to this installation.
   2. Compliance with Local Requirements: Comply with applicable building code, local ordinances and regulations, and requirements of authorities having jurisdiction.
   3. Comply with NFPA 72.
   4. The Installing Contractor (and any Subcontractors working for the Installing Contractor) shall be licensed, in accordance with local, regional and state authorities having jurisdiction, to complete the work that they are contracted to perform.

1.6 SEQUENCING AND SCHEDULING

A. Existing Fire Alarm Equipment: Maintain fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire alarm equipment "NOT IN SERVICE" until removed from the building.

B. Equipment Removal: After acceptance of the new fire alarm system, remove existing disconnected fire alarm equipment and restore damaged surfaces.

1. Package operational fire alarm and detection equipment that has been removed and deliver to Owner.
2. Remove from site and legally dispose of existing material not designated for other disposition.

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.
1. Strobe Units: Quantity equal to 10 percent of amount installed, but not less than one unit.
2. Ceiling Mount Smoke Detectors and Heat Detectors: Quantity equal to 10 percent of amount of each type installed, but not less than one unit of each type.
3. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but not less than one unit of each type.
4. Addressable Control Modules: Quantity equal to 2 percent of amount of each type installed, but not less than one unit of each type.
5. Keys and Tools: One extra set for access to locked and tamperproofed components.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. EST.
2. Gamewell/FCI.
3. Notifier; Div. of Pittway Corp.
4. Siemens.

2.2 FUNCTIONAL DESCRIPTION OF SYSTEM

A. Control of System: By the FACP.

B. System Supervision: Automatically detect and report open circuits, shorts, and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.

C. Priority of Signals: Automatic alarm response functions resulting from an alarm signal from one zone or device are not altered by subsequent alarm, supervisory, or trouble signals. An alarm signal is the highest priority. Supervisory and trouble signals have second- and third-level priority. Higher-priority signals take precedence over signals of lower priority, even when

the lower-priority condition occurs first. Annunciate and display all alarm, supervisory, and trouble signals regardless of priority or order received.

D. Noninterference: A signal on one zone shall not prevent the receipt of signals from other zones.

E. System Reset: All zones are manually resettable from the FACP after initiating devices are restored to normal.

F. Transmission to Remote Alarm Receiving Station: Automatically route alarm, supervisory, and trouble signals to a remote alarm station by means of a digital alarm communicator transmitter and telephone lines.

G. Transmission to Remote Alarm Receiving Station: Automatically route alarm, supervisory, and trouble signals to a remote alarm receiving station by means of a radio alarm transmitter.

H. Remote Alarms: Automatically route alarm, supervisory, and trouble signals to the Building Energy Management System or the Building Access Control and Security Management System.

I. Loss of primary power at the FACP initiates a trouble signal at the FACP. The FACP indicates when the fire alarm system is operating on the secondary power supply.

J. Basic Alarm Performance Requirements: Unless otherwise indicated, operation of a manual station, automatic alarm operation of a smoke (duct type smoke detector shall result in either an alarm or a supervisory condition as required required by the AHJ) or flame or heat detector initiates the following:

1. Notification-appliance operation.
2. Identification at the FACP of the device originating the alarm.
3. Transmission of an alarm signal to the remote alarm receiving station.
4. Transmission of an alarm signal to the Building Energy Management System or the Building Access Control and Security Management System.
5. Release of fire and smoke doors held open by magnetic door holders.
6. Shutdown of fans and other air-handling equipment serving zone where alarm was initiated.
7. Closing of smoke dampers in air ducts of system serving zone where alarm was initiated.
8. Recording of the event in the system memory.

K. Alarm Silencing, System Reset and Indication: Controlled by switches in the FACP.

1. Silencing-switch operation halts alarm operation of notification appliances and activates an "alarm silence" light. Display of identity of the alarm zone or device is retained.
2. Subsequent alarm signals from other devices or zones reactivate notification appliances until silencing switch is operated again.
3. When alarm-initiating devices return to normal and system reset switch is operated, notification appliances operate again until alarm silence switch is reset.

L. Removal of an alarm-initiating device or a notification appliance initiates the following:

1. A "trouble" signal indication at the FACP and the annunciator for the device or zone involved.
2. Recording of the event in the system memory.
3. Transmission of trouble signal to remote alarm receiving station.

M. FACP Alphanumeric Display: Plain-English-language descriptions of alarm, supervisory, and trouble events; and addresses and locations of alarm-initiating or supervisory devices originating the report. Display monitoring actions, system and component status, system commands, programming information, and data from the system's historical memory.

2.3 MANUAL PULL STATIONS

A. Description: Fabricated of metal or lexan, and finished in red with molded, raised-letter operating instructions of contrasting color.

1. Double-action mechanism requires two actions, such as a push and a pull, to initiate an alarm. Break glass stations are not acceptable.
2. Station Reset: Key or wrench operated; double pole, double throw; switch rated for the voltage and current at which it operates.
3. Indoor Protective Shield: Factory-fabricated clear plastic enclosure, hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false alarm operation.
4. Integral Addressable Module: Arranged to communicate manual-station status (normal, alarm, or trouble) to the FACP.

2.4 SMOKE DETECTORS

A. General: Include the following features:

1. Operating Voltage: 24-V dc, nominal.
2. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
3. Plug-in Arrangement: Detector and associated electronic components are mounted in a module that connects in a tamper-resistant manner to a fixed base with a twist-locking plug connection. Terminals in the fixed base accept building wiring.
4. Integral Visual-Indicating Light: LED type. Indicates detector has operated.
5. Sensitivity: Can be tested and adjusted in-place after installation.
6. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

B. Photoelectric Smoke Detectors: Include the following features:

1. Sensor: LED or infrared light source with matching silicon-cell receiver.
2. Detector Sensitivity: Between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) smoke obscuration when tested according to UL 268A.

C. Duct Smoke Detector: Photoelectric type.

1. Sampling Tube: Design and dimensions as recommended by the manufacturer for the specific duct size, air velocity, and installation conditions where applied.
2. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

D. Beam-Type Smoke Detector: Each detector consists of a separate transmitter and receiver with the following features:

1. Adjustable Sensitivity: More than a six-level range, minimum.

2. Linear Range of Coverage: 60 feet by 200 feet, minimum.
3. Tamper Switch: Initiates trouble signal at the central FACP when either transmitter or receiver is disturbed.
4. Separate Color-Coded LEDs: Indicate normal, alarm, and trouble status. Any detector trouble, including power loss, is reported to the central FACP as a composite "trouble" signal.

2.5 OTHER DETECTORS

A. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or rate of rise of temperature that exceeds 15 deg F (8.3 deg C) per minute, unless otherwise indicated.

1. Mounting: Plug-in base, interchangeable with smoke detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

2.6 NOTIFICATION APPLIANCES

A. Description: Equip for mounting as indicated and have screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly.
2. Weatherproof where indicated.
3. Where shown to be ceiling mounted, units shall be listed for ceiling mount application.
4. Devices shall have white finish.

B. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Horns produce a sound-pressure level of 90 dB, measured 10 feet (3 m) from the horn.

1. Horn audibility level shall be field selectable to suit conditions.

C. Visible Alarm Devices: Xenon strobe lights listed under UL 1971 with clear or nominal white polycarbonate lens. Mount lens on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.

1. Rated Light Output: 15/75 candela, unless noted otherwise on plans.
2. Devices shall be synchronized as required by applicable codes.
3. Strobe Leads: Factory connected to screw terminals.

2.7 REMOTE DEVICE LOCATION-REMOTE TEST/INDICATING LIGHTS AND IDENTIFICATION PLATES

A. Description: Remote test station with LED indicating light and remote test key switch near each smoke detector that may not be readily visible. Light is connected to flash when the associated device is in an alarm or trouble mode. Lamp and test switch are flush mounted in a single gang wall plate. A red, laminated, phenolic-resin identification plate at the indicating light identifies, in engraved white letters, device initiating the signal and room where the smoke detector is located.

2.8 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching door plate.

1. Electromagnet: Requires no more than 3 W to develop 25-lbf (111-N) holding force.
2. Wall-Mounted Units: Flush mounted, unless otherwise indicated. Provide catch plate extensions as required for holding door.
3. Rating: 24-V ac or dc.

B. Material and Finish: Match door hardware.

2.9 CENTRAL FACP

A. Cabinet: Lockable steel enclosure. Arrange interior components so operations required for testing or for normal maintenance of the system are performed from the front of the enclosure. If more than one unit is required to form a complete control panel, fabricate with matching modular unit enclosure to accommodate components and to allow ample gutter space for field wiring and interconnecting panels.

1. Identify each enclosure with an engraved, red, laminated, phenolic-resin nameplate with lettering not less than 1 inch (25 mm) high. Identify individual components and modules within cabinets with permanent labels.
2. Mounting: Surface.

B. Alarm and Supervisory Systems: Separate and independent in the FACP. Alarm-initiating zone boards consist of plug-in cards. Construction requiring removal of field wiring for module replacement is unacceptable.

C. Control Modules: Include types and capacities required to perform all functions of fire alarm systems.

D. Minimum Number of Intelligent Detection Input Points: 240 (future 20,000 square foot addition) or 125% of the connected addressable devices, whichever is greater.

E. Networking: Shall be capable of interfacing with other intelligent control panels of the same manufacture to form a network. Each local control panel (network node) shall maintain its own area of protection, while monitoring and controlling other areas (other network nodes) allowing true peer-to-peer communications.

F. Indications: Local, visible, and audible signals announce alarm, supervisory, and trouble conditions. Each type of audible alarm has a different sound.

G. Resetting Controls: Prevent the resetting of alarm, supervisory, or trouble signals while the alarm or trouble condition still exists.

H. Alphanumeric Display and System Controls: Arranged for interface between human operator at the FACP and addressable system components, including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Display: Liquid-crystal type, 40 characters, minimum.

2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

2.10 NOTIFICATION APPLIANCE CIRCUIT POWER EXTENDER PANEL

A. Provide additional panels as required for operation of notification appliances.
   1. Panel shall provide synchronization of strobes at a rate of 1Hz and operate horns with a temporal code pattern.
   2. Panel shall provide the capability to silence the audible signals, while the strobes continue to flash.
   3. Panel shall provide the capability to synchronize multiple notification appliance circuits.

2.11 EMERGENCY POWER SUPPLY

A. General: Components include valve-regulated, recombinant lead acid battery; charger; and an automatic transfer switch.

   1. Battery Nominal Life Expectancy: 4 years, minimum.

B. Battery Capacity: Comply with NFPA 72.

   1. Magnetic door holders are not served by emergency power. Magnetic door holders are released when normal power fails.

C. Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Provide capacity for 150 percent of the connected system load while maintaining batteries at full charge. If batteries are fully discharged, the charger recharges them completely within four hours. Charger output is supervised as part of system power supply supervision.

D. Integral Automatic Transfer Switch: Transfers the load to the battery without loss of signals or status indications when normal power fails.

2.12 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module listed for use in providing a multiplex system address for listed fire and sprinkler alarm-initiating devices with normally open contacts.

B. Integral Relay: Capable of providing a direct signal to a elevator controller to initiate elevator recall or to a circuit-breaker shunt trip for power shutdown.

2.13 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Listed and labeled under UL 864 and NFPA 72.

B. Functional Performance: Unit receives an alarm, supervisory, or trouble signal from the FACP panel, and automatically captures one or two telephone lines and dials a preset number for a remote central station. When contact is made with the central station(s), the signal is transmitted. The unit supervises up to two telephone lines. Where supervising two lines, if service on either line is interrupted for longer than 45 seconds, the unit initiates a local trouble signal and transmits a signal indicating loss of telephone line to the remote alarm receiving

station over the remaining line. When telephone service is restored, unit automatically reports that event to the central station. If service is lost on both telephone lines, the local trouble signal is initiated.

C. Secondary Power: Integral rechargeable battery and automatic charger. Battery capacity is adequate to comply with NFPA 72 requirements.

D. Self Test: Conducted automatically every 24 hours with report transmitted to central station.

2.14 WIRE

A. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation. Sized per manufacturer requirements.

B. Power-Limited Circuits: NFPA 70, Types FPL, FPLR, or FPLP, as recommended by manufacturer.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. The installation shall be in accordance with the latest requirements of the NEC, State, and Local Codes, ordinances and regulations of any other governing body having jurisdiction

B. All equipment shall be installed in a neat and workmanlike manner and to the satisfaction of the Project Engineer.

C. Provide a smoke detector at the FACP and each notification appliance circuit signal power extender panel.

D. Manual Pull Stations: Mount semiflush in recessed back boxes.

E. Ceiling-Mounted Smoke Detectors: Not less than 4 inches (100 mm) from a side wall to the near edge. For exposed solid-joist construction, mount detectors on the bottom of joists. On smooth ceilings, install not more than 30 feet (9 m) apart in any direction.

F. Smoke Detectors near Air Registers: Install no closer than 36 inches.

G. Duct Smoke Detectors: Comply with manufacturer's written instructions.

1. Verify that each unit is listed for the complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
2. Install sampling tubes so they extend the full width of the duct.

H. Interface with Mechanical HVAC Equipment:

1. Coordinate with the mechanical contractor the zoning of smoke detectors for control of smoke dampers. Provide control outputs and relays for zoned control of smoke dampers as required.
2. Provide alarm output signals and wiring to the building automation system and all HVAC equipment motor starters and/or AFD controllers for fan shutdown upon alarm as

required by the International Mechanical Code. Coordinate requirements with mechanical contractor.

I. Wall Mounted Audible Alarm-Indicating Devices: Install with top of device not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Combine audible and visible alarms at the same location into a single unit.

J. Wall Mounted Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and with top of device at least 6 inches (150 mm) below the ceiling.

K. Notification Appliance Circuits: Connected appliance load shall not exceed 80% of the allowable circuit load.

L. Remote Device Location-Remote Test/Indicating Lights and Identification Plates: Provide for each smoke detector which is not readily visible and locate in public space near the device they monitor.

M. FACP: Mount with tops of cabinets not more than 72 inches (1830 mm) above the finished floor. Wiring splices shall not be made in the control panel enclosure.

3.2 WIRING INSTALLATION

A. Wiring Method: Install wiring in raceway except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces. All wiring installed underground or underslab shall be wet location listed.
   1. Raceway and boxes shall be installed in accordance with Division 26 Section “Raceway and Boxes”.
   2. “Free-Air” Cabling techniques are NOT acceptable for this project. All cables shall be in raceway.

B. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by the manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

C. Cable Taps: Use numbered terminal strips in junction, pull and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

D. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction box covers red in non-public, un-finished spaces, and above accessible ceilings.

E. Wiring to Remote Alarm Transmitting Device: 1-inch (25-mm) conduit between the FACP and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals according to Division 26 Section "Basic Electrical Materials and Methods."

3.4 COORDINATION OF CENTRAL REPORTING

A. Coordinate central reporting requirements and connections with the owner, telephone switch provider, and local utility.
   1. Ensure that arriving phone lines intended for connection for fire alarm central station reporting use are properly routed, terminated, and labeled at all points in this building.
   2. Where lines are to be “shared” use, wiring shall first route through the fire alarm system dialing equipment and then on to the telephone switch. Wire terminations through line seizure modules are to be made in a manner that ensures capture and use by the fire alarm equipment in an emergency.

3.5 GROUNDING

A. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding.

B. Install grounding electrodes of type, size, location, and quantity as indicated. Comply with installation requirements in Division 26 Section "Grounding."

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and connections and to supervise pretesting, testing, and adjustment of the system. Report results in writing.

B. Pretesting: After installation, align, adjust, and balance the system and perform complete pretesting. Determine, through pretesting, the compliance of the system with requirements of Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones, and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.

C. Report of Pretesting: After pretesting is complete, provide a letter certifying the installation is complete and fully operable, including the names and titles of witnesses to preliminary tests.

D. Final Test Notice: Provide a minimum of 10 days' notice in writing when the system is ready for final acceptance testing.

E. Minimum System Tests: Test the system according to procedures outlined in NFPA 72. Minimum required tests are as follows:

   1. Verify the absence of unwanted voltages between circuit conductors and ground.
   2. Test all conductors for short circuits using an insulation-testing device.
   3. With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohmmeter. Record the circuit resistance of each circuit on record drawings.

4. Verify that the control unit is in the normal condition as detailed in the manufacturer's operation and maintenance manual.
5. Test initiating and indicating circuits for proper signal transmission under open circuit conditions. One connection each should be opened at not less than 10 percent of initiating and indicating devices. Observe proper signal transmission according to class of wiring used.
6. Test each initiating and indicating device for alarm operation and proper response at the control unit. Test smoke detectors with actual products of combustion.
7. Test the system for all specified functions according to the approved operation and maintenance manual. Systematically initiate specified functional performance items at each station, including making all possible alarm and monitoring initiations and using all communications options. For each item, observe related performance at all devices required to be affected by the item under all system sequences. Observe indicating lights, displays, signal tones, and annunciator indications.
8. Test Both Primary and Secondary Power: Verify by test that the secondary power system is capable of operating the system for the period and in the manner specified.

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 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. Submit log on the satisfactory completion of tests.

H. Tag all equipment, stations, and other components at which tests have been satisfactorily completed.

3.7 CLEANING AND ADJUSTING

A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marred finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, adjusting, and maintaining equipment and schedules. Provide a minimum of 4 hours' training.
2. Training Aid: Use the approved final version of the operation and maintenance manual as a training aid.
3. Schedule training with Owner, through Architect/Engineer, with at least seven days advance notice.

3.9 ON-SITE ASSISTANCE

A. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels, controls, and sensitivities to suit actual occupied conditions. Provide up to two requested visits to Project site for this purpose.

END OF SECTION 287210

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SECTION 287211 - FIRE ALARM SYSTEM (Madison Elementary)

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 fire alarm systems with manual stations, detectors, signal equipment, controls, and devices.

B. Related Sections include the following:

1.3 SYSTEM DESCRIPTION

A. General: All new fire alarm devices shall be connected to the existing EST fire alarm system. All new field devices shall be UL listed with the existing system and shall operate in a compatible, seamless manner. Where required by applicable codes, existing and new notification devices shall be synchronized. Expand and upgrade the existing system as required for a complete operating system.

B. General: The new system shall be a noncoded, addressable system with manual and automatic alarm initiation; and multiplexed signal transmission dedicated to fire alarm service only.

C. Wiring Class and Style: Initiating device circuits and signaling line circuits shall be Class B.

1.4 SUBMITTALS, SHOP DRAWINGS & MAINTENANCE MANUALS

A. Submittals shall be provided in accordance with Division 1 and as further described herein.

B. Submittals shall include major equipment material lists, summarizing every item to be provided, by manufacturer, part number, quantity, and include a brief summary of each item. Manufacturer’s product data sheets, describing each of the major components shall also be provided.

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   1. Battery: Provide battery sizing calculations for the control panel and each power expander for actual connected loads.
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2. All basic electronic equipment shall be listed by Underwriter's Laboratories, Inc. for the application and shall be products of manufacturers of established reputation and experience.
3. Obtain fire alarm system components through one source from a single manufacturer.

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1. The Installing Contractor shall be a firm specializing in the type of work called out in this specification section and shall, upon request, provide documentation that they have successfully completed at least three other installations of similar size and scope to this installation.
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4. The Installing Contractor (and any Subcontractors working for the Installing Contractor) shall be licensed, in accordance with local, regional and state authorities having jurisdiction, to complete the work that they are contracted to perform.

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2. Remove from site and legally dispose of existing material not designated for other disposition.

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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. Strobe Units: Quantity equal to 10 percent of amount installed, but not less than one unit.
2. Ceiling Mount Smoke Detectors and Heat Detectors: Quantity equal to 10 percent of amount of each type installed, but not less than one unit of each type.
3. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but not less than one unit of each type.
4. Addressable Control Modules: Quantity equal to 2 percent of amount of each type installed, but not less than one unit of each type.
5. Keys and Tools: One extra set for access to locked and tamperproofed components.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. EST.

2.2 FUNCTIONAL DESCRIPTION OF SYSTEM

A. Control of System: By the FACP.

B. System Supervision: Automatically detect and report open circuits, shorts, and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.

C. Priority of Signals: Automatic alarm response functions resulting from an alarm signal from one zone or device are not altered by subsequent alarm, supervisory, or trouble signals. An alarm signal is the highest priority. Supervisory and trouble signals have second- and third-level priority. Higher-priority signals take precedence over signals of lower priority, even when

the lower-priority condition occurs first. Annunciate and display all alarm, supervisory, and trouble signals regardless of priority or order received.

D. Noninterference: A signal on one zone shall not prevent the receipt of signals from other zones.

E. System Reset: All zones are manually resettable from the FACP after initiating devices are restored to normal.

F. Transmission to Remote Alarm Receiving Station: Automatically route alarm, supervisory, and trouble signals to a remote alarm station by means of a digital alarm communicator transmitter and telephone lines.

G. Remote Alarms: Automatically route alarm, supervisory, and trouble signals to the Building Energy Management System or the Building Access Control and Security Management System.

H. Loss of primary power at the FACP initiates a trouble signal at the FACP. The FACP indicates when the fire alarm system is operating on the secondary power supply.

I. Basic Alarm Performance Requirements: Unless otherwise indicated, operation of a manual station, automatic alarm operation of a smoke (duct type smoke detector shall result in either an alarm or a supervisory condition as required required by the AHJ) or flame or heat detector initiates the following:

1. Notification-appliance operation.
2. Identification at the FACP of the device originating the alarm.
3. Transmission of an alarm signal to the remote alarm receiving station.
4. Transmission of an alarm signal to the Building Energy Management System or the Building Access Control and Security Management System.
5. Release of fire and smoke doors held open by magnetic door holders.
6. Shutdown of fans and other air-handling equipment serving zone where alarm was initiated.
7. Closing of smoke dampers in air ducts of system serving zone where alarm was initiated.
8. Recording of the event in the system memory.

J. Alarm Silencing, System Reset and Indication: Controlled by switches in the FACP.

1. Silencing-switch operation halts alarm operation of notification appliances and activates an "alarm silence" light. Display of identity of the alarm zone or device is retained.
2. Subsequent alarm signals from other devices or zones reactivate notification appliances until silencing switch is operated again.
3. When alarm-initiating devices return to normal and system reset switch is operated, notification appliances operate again until alarm silence switch is reset.

K. Removal of an alarm-initiating device or a notification appliance initiates the following:

1. A "trouble" signal indication at the FACP and the annunciator for the device or zone involved.
2. Recording of the event in the system memory.
3. Transmission of trouble signal to remote alarm receiving station.

L. FACP Alphanumeric Display: Plain-English-language descriptions of alarm, supervisory, and trouble events; and addresses and locations of alarm-initiating or supervisory devices

originating the report. Display monitoring actions, system and component status, system commands, programming information, and data from the system's historical memory.

2.3 MANUAL PULL STATIONS

A. Description: Fabricated of metal or lexan, and finished in red with molded, raised-letter operating instructions of contrasting color.

1. Double-action mechanism requires two actions, such as a push and a pull, to initiate an alarm. Break glass stations are not acceptable.
2. Station Reset: Key or wrench operated; double pole, double throw; switch rated for the voltage and current at which it operates.
3. Indoor Protective Shield: Factory-fabricated clear plastic enclosure, hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false alarm operation.
4. Integral Addressable Module: Arranged to communicate manual-station status (normal, alarm, or trouble) to the FACP.

2.4 SMOKE DETECTORS

A. General: Include the following features:

1. Operating Voltage: 24-V dc, nominal.
2. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
3. Plug-in Arrangement: Detector and associated electronic components are mounted in a module that connects in a tamper-resistant manner to a fixed base with a twist-locking plug connection. Terminals in the fixed base accept building wiring.
4. Integral Visual-Indicating Light: LED type. Indicates detector has operated.
5. Sensitivity: Can be tested and adjusted in-place after installation.
6. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

B. Photoelectric Smoke Detectors: Include the following features:

1. Sensor: LED or infrared light source with matching silicon-cell receiver.
2. Detector Sensitivity: Between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) smoke obscuration when tested according to UL 268A.

C. Duct Smoke Detector: Photoelectric type.

1. Sampling Tube: Design and dimensions as recommended by the manufacturer for the specific duct size, air velocity, and installation conditions where applied.
2. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

D. Beam-Type Smoke Detector: Each detector consists of a separate transmitter and receiver with the following features:

1. Adjustable Sensitivity: More than a six-level range, minimum.
2. Linear Range of Coverage: 60 feet by 200 feet, minimum.

3. Tamper Switch: Initiates trouble signal at the central FACP when either transmitter or receiver is disturbed.
4. Separate Color-Coded LEDs: Indicate normal, alarm, and trouble status. Any detector trouble, including power loss, is reported to the central FACP as a composite "trouble" signal.

2.5 OTHER DETECTORS

A. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or rate of rise of temperature that exceeds 15 deg F (8.3 deg C) per minute, unless otherwise indicated.

1. Mounting: Plug-in base, interchangeable with smoke detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

2.6 NOTIFICATION APPLIANCES

A. Description: Equip for mounting as indicated and have screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly.
2. Weatherproof where indicated.
3. Where shown to be ceiling mounted, units shall be listed for ceiling mount application.
4. Devices shall have white finish.

B. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Horns produce a sound-pressure level of 90 dB, measured 10 feet (3 m) from the horn.

1. Horn audibility level shall be field selectable to suit conditions.

C. Visible Alarm Devices: Xenon strobe lights listed under UL 1971 with clear or nominal white polycarbonate lens. Mount lens on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.

1. Rated Light Output: 15/75 candela, unless noted otherwise on plans.
2. Devices shall be synchronized as required by applicable codes.
3. Strobe Leads: Factory connected to screw terminals.

2.7 REMOTE DEVICE LOCATION-REMOTE TEST/INDICATING LIGHTS AND IDENTIFICATION PLATES

A. Description: Remote test station with LED indicating light and remote test key switch near each smoke detector that may not be readily visible. Light is connected to flash when the associated device is in an alarm or trouble mode. Lamp and test switch are flush mounted in a single gang wall plate. A red, laminated, phenolic-resin identification plate at the indicating light identifies, in engraved white letters, device initiating the signal and room where the smoke detector is located.

2.8 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching door plate.

1. Electromagnet: Requires no more than 3 W to develop 25-lbf (111-N) holding force.
2. Wall-Mounted Units: Flush mounted, unless otherwise indicated. Provide catch plate extensions as required for holding door.
3. Rating: 24-V ac or dc.

B. Material and Finish: Match door hardware.

2.9 CENTRAL FACP

A. Cabinet: Existing, upgrade as required for system expansion.

2.10 NOTIFICATION APPLIANCE CIRCUIT POWER EXTENDER PANEL

A. Provide additional panels as required for operation of notification appliances.
1. Panel shall provide synchronization of strobes at a rate of 1Hz and operate horns with a temporal code pattern.
2. Panel shall provide the capability to silence the audible signals, while the strobes continue to flash.
3. Panel shall provide the capability to synchronize multiple notification appliance circuits.

2.11 EMERGENCY POWER SUPPLY

A. General: Components include valve-regulated, recombinant lead acid battery; charger; and an automatic transfer switch.

1. Battery Nominal Life Expectancy: 4 years, minimum.

B. Battery Capacity: Comply with NFPA 72.

1. Magnetic door holders are not served by emergency power. Magnetic door holders are released when normal power fails.

C. Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Provide capacity for 150 percent of the connected system load while maintaining batteries at full charge. If batteries are fully discharged, the charger recharges them completely within four hours. Charger output is supervised as part of system power supply supervision.

D. Integral Automatic Transfer Switch: Transfers the load to the battery without loss of signals or status indications when normal power fails.

2.12 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module listed for use in providing a multiplex system address for listed fire and sprinkler alarm-initiating devices with normally open contacts.

B. Integral Relay: Capable of providing a direct signal to a elevator controller to initiate elevator recall or to a circuit-breaker shunt trip for power shutdown.

2.13 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Existing, upgrade as required for system expansion.

2.14 WIRE

A. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation. Sized per manufacturer requirements.

B. Power-Limited Circuits: NFPA 70, Types FPL, FPLR, or FPLP, as recommended by manufacturer.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. The installation shall be in accordance with the latest requirements of the NEC, State, and Local Codes, ordinances and regulations of any other governing body having jurisdiction

B. All equipment shall be installed in a neat and workmanlike manner and to the satisfaction of the Project Engineer.

C. Provide a smoke detector at the FACP and each notification appliance circuit signal power extender panel.

D. Manual Pull Stations: Mount semiflush in recessed back boxes.

E. Ceiling-Mounted Smoke Detectors: Not less than 4 inches (100 mm) from a side wall to the near edge. For exposed solid-joist construction, mount detectors on the bottom of joists. On smooth ceilings, install not more than 30 feet (9 m) apart in any direction.

F. Smoke Detectors near Air Registers: Install no closer than 36 inches.

G. Duct Smoke Detectors: Comply with manufacturer's written instructions.

1. Verify that each unit is listed for the complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
2. Install sampling tubes so they extend the full width of the duct.

H. Interface with Mechanical HVAC Equipment:

1. Coordinate with the mechanical contractor the zoning of smoke detectors for control of smoke dampers. Provide control outputs and relays for zoned control of smoke dampers as required.
2. Provide alarm output signals and wiring to the building automation system and all HVAC equipment motor starters and/or AFD controllers for fan shutdown upon alarm as

required by the International Mechanical Code. Coordinate requirements with mechanical contractor.

I. Wall Mounted Audible Alarm-Indicating Devices: Install with top of device not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Combine audible and visible alarms at the same location into a single unit.

J. Wall Mounted Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and with top of device at least 6 inches (150 mm) below the ceiling.

K. Notification Appliance Circuits: Connected appliance load shall not exceed 80% of the allowable circuit load.

L. Remote Device Location-Remote Test/Indicating Lights and Identification Plates: Provide for each smoke detector which is not readily visible and locate in public space near the device they monitor.

3.2 WIRING INSTALLATION

A. Wiring Method: Install wiring in raceway except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces. All wiring installed underground or underslab shall be wet location listed.
   1. Raceway and boxes shall be installed in accordance with Division 26 Section “Raceway and Boxes”.
   2. “Free-Air” Cabling techniques are NOT acceptable for this project. All cables shall be in raceway.

B. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by the manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

C. Cable Taps: Use numbered terminal strips in junction, pull and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

D. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction box covers red in non-public, un-finished spaces, and above accessible ceilings.

E. Wiring to Remote Alarm Transmitting Device: 1-inch (25-mm) conduit between the FACP and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals according to Division 26 Section "Basic Electrical Materials and Methods."

3.4 COORDINATION OF CENTRAL REPORTING

A. Coordinate central reporting requirements and connections with the owner, telephone switch provider, and local utility.
   1. Ensure that arriving phone lines intended for connection for fire alarm central station reporting use are properly routed, terminated, and labeled at all points in this building.
   2. Where lines are to be “shared” use, wiring shall first route through the fire alarm system dialing equipment and then on to the telephone switch. Wire terminations through line seizure modules are to be made in a manner that ensures capture and use by the fire alarm equipment in an emergency.

3.5 GROUNDING

A. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding.

B. Install grounding electrodes of type, size, location, and quantity as indicated. Comply with installation requirements in Division 26 Section "Grounding."

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and connections and to supervise pretesting, testing, and adjustment of the system. Report results in writing.

B. Pretesting: After installation, align, adjust, and balance the system and perform complete pretesting. Determine, through pretesting, the compliance of the system with requirements of Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones, and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.

C. Report of Pretesting: After pretesting is complete, provide a letter certifying the installation is complete and fully operable, including the names and titles of witnesses to preliminary tests.

D. Final Test Notice: Provide a minimum of 10 days' notice in writing when the system is ready for final acceptance testing.

E. Minimum System Tests: Test the system according to procedures outlined in NFPA 72. Minimum required tests are as follows:

   1. Verify the absence of unwanted voltages between circuit conductors and ground.
   2. Test all conductors for short circuits using an insulation-testing device.
   3. With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohmmeter. Record the circuit resistance of each circuit on record drawings.
   4. Verify that the control unit is in the normal condition as detailed in the manufacturer's operation and maintenance manual.

5. Test initiating and indicating circuits for proper signal transmission under open circuit conditions. One connection each should be opened at not less than 10 percent of initiating and indicating devices. Observe proper signal transmission according to class of wiring used.
6. Test each initiating and indicating device for alarm operation and proper response at the control unit. Test smoke detectors with actual products of combustion.
7. Test the system for all specified functions according to the approved operation and maintenance manual. Systematically initiate specified functional performance items at each station, including making all possible alarm and monitoring initiations and using all communications options. For each item, observe related performance at all devices required to be affected by the item under all system sequences. Observe indicating lights, displays, signal tones, and annunciator indications.
8. Test Both Primary and Secondary Power: Verify by test that the secondary power system is capable of operating the system for the period and in the manner specified.

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 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. Submit log on the satisfactory completion of tests.

H. Tag all equipment, stations, and other components at which tests have been satisfactorily completed.

3.7 CLEANING AND ADJUSTING

A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marred finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, adjusting, and maintaining equipment and schedules. Provide a minimum of 4 hours' training.
2. Training Aid: Use the approved final version of the operation and maintenance manual as a training aid.
3. Schedule training with Owner, through Architect/Engineer, with at least seven days advance notice.

3.9 ON-SITE ASSISTANCE

A. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels, controls, and sensitivities to suit actual occupied conditions. Provide up to two requested visits to Project site for this purpose.

END OF SECTION 287211